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PHYSICIANS' PAYMENT AND THEIR PRESCRIPTION OF LABORATORY TESTS: THE EFFECTS ON CLINICAL LABORATORY SERVICES OF SELECTED ALTERNATIVES FOR PAYING PHYSICIANS UNDER THE MEDICARE PROGRAM

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Table of Contents

		Page
1.	Introduction	1
2.	Why Physicians Order Tests	6
3.	Financial Incentives and Physicians' Ordering of Services	17
4.	Payment Systems for Physicians and Laboratory Tests	40
5.	Site of Laboratory Testing	60
6.	Costing of Laboratory Tests	91
7.	Physician Payment Options and Incentives	109
8.	Conclusion	144
9.	References	153
10.	Appendix	163

1. Introduction

Major reforms in Medicare payment for inpatient care introduced fundamental changes in the incentives for hospitals. There is now enthusiasm in many quarters today to reform the Medicare system of physician payment as well. The nature of the change in physician payment is not yet clear, but what seems certain is that payment will not be as open-ended as it has been in the past.

What will be the impact of the new Medicare physician payment system on the cost and quality of care, patients' access to appropriate care, hospitalization rates, and use of ancillary services? This report addresses one aspect of that question: the potential effect of different physician payment schemes on use of laboratory tests.

Laboratory testing is deserving of close scrutiny. As many as 6.2 billion laboratory tests are performed each year, amounting to $11 - 30 billion in payments (Danzon 1983; Pinckney 1983; Marquis, 1984; Biomed. Bus. Interna., 1984, personal communication P. Lupovich, Group Health Association, 1985). Laboratory testing has grown by 10-15 percent per year since the early 1950's (Danzon 1983, 1984; Marquis, 1984). Use

of some laboratory tests has grown at even more remarkable rates. For example, during a five-year period (1977-1982), use of occult blood determinations and platelet counts for Medicare patients increased by 267 percent and 105 percent, respectively (Etheredge, Juba, 1985). This increase in testing has been due to population growth as well as increased use of laboratory tests per patient. In addition, a number of new tests have been introduced. For instance, such commonly used tests as Hemoccult cards, ferritin, and glycosylated hemoglobin were not widely available ten years ago.

This report discusses laboratory testing in light of physician payment methods under Medicare. Its sections address the reasons why physicians order laboratory tests; the impact of financial incentives on physician ordering; modes of payment for physician and laboratory services; sites of laboratory testing; costing of laboratory services; and the impact of alternative physician payment systems on the use of laboratory tests. The report focuses primarily on laboratory testing in the outpatient setting, assuming that inpatient laboratory testing is covered by the DRG-based Prospective Payment System rates of Medicare

Part A. This report also highlights a factor that is emerging as an important issue in laboratory testing: the site of testing, especially physician in-office laboratories.

The purpose of the report is sixfold:

1. To discuss factors that influence physician test-ordering;

2. To document current arrangements by which Medicare pays for clinical laboratory services;

3. To present available information on the cost of producing laboratory tests;

4. To analyze effects of alternative payment methods;

5. To assess the potential effects of different payment methods and financial arrangements on the use and cost of laboratory services, settings in which services are performed,

quality of care, substitution of services, access to care, and innovation; and

6. To discuss policy implications of the findings.

In conducting this study, we reviewed research literature on physician practice patterns, use of laboratory tests, responses to changes in payment systems, induced demand and other economic theories and studies, and cost of laboratory tests. We also reviewed the trade literature regarding the growth of office laboratories, the cost of laboratory testing, innovations and new trends in office testing, and physician incentives. In addition, we contacted key individuals in the field. These included practicing physicians, directors of laboratories, health services researchers, clinic directors, quality assurance specialists, group practice association directors, management consultants, and directors of health care insurance programs. Finally, we reviewed regulations affecting Medicare payment for physician and laboratory services and regulations regarding quality of care in laboratory testing.

For some topics, such as physician practice patterns and incentives within the fee-for-service system, there is abundant evidence and a wealth of thoughtful research and analysis. Other topics represent new territory, however. These include 1) the nature, use, and growth of physician office laboratories, 2) the true cost of laboratory tests, especially as determined in different settings (hospital, independent, or physician office laboratory), 3) the potential use of laboratory tests under various physician payment packaging schemes (except capitation), and 4) the relationship between payment for physician services and the use of laboratory tests.

Using information on payment and quality regulations, incentives, practice patterns, costs, site of testing, and alternative physician payment models, we have tried to illuminate the important issues surrounding laboratory testing and physician payment and to anticipate the potential impact of new payment systems on laboratory testing.

2. Why Physicians Order Tests

The primary goal of physicians is to assure the health of their patients. The use of laboratory tests is one means among many of achieving that goal. Laboratory tests are ordered to establish clinical baseline values, assist in diagnosis, assess prognosis, monitor therapy, and reassure patients (or their physicians) (Epstein, McNeil, 1985, The relationship; Eisenberg, Doctors' Decisions). Substantial variability among physicians in test ordering suggests, however, that clinical indications for diagnostic tests are less than absolute and that other factors may strongly influence physician ordering decisions. Physicians have been found to vary as much as 17-fold in the use of laboratory tests even when caring for similar patients in an outpatient setting (Daniels, Schroeder, 1977; Read, Stern, Thibodeau et al, 1983). Moreover, physicians know whether they use more or fewer tests than other physicians, even for patients with the same diagnosis (Epstein, McNeil, 1985, The relationship). Younger physicians tend to use more tests than older

physicians; specialists, more than generalists (Eisenberg, Nicklin, 1981; Greenwald, Peterson, Garrison et al, 1984; Freeborn, Baer, Greenlick et al, 1972; Childs, Hunter, 1972; Roos, 1982).

Uncertainty also may affect physicians' use of laboratory tests. When a clinical situation is highly ambiguous, physicians tend to order more (Pineault, 1977). Uncertainty may explain some of the differences in ordering between teaching and community hospitals since housestaff are more likely to be uncertain in their patient care. Other factors, however, such as case mix and the influence of supervising physicians, also may contribute (Schroeder, O'Leary, 1977).

Numerous other factors affect physicians' ordering of laboratory tests as well. They may affect the use of laboratory tests in several ways, including:

1. the volume of tests ordered (either increase or decrease),
2. the types of tests ordered, and
3. the choice of test site (hospital, independent, or office-based laboratory).

These factors can be described in three general categories: those that are based on the physician's own benefit, those based on the patient's benefit, and those based on the benefit of society at large (Eisenberg, Doctors' Decisions; Eisenberg, 1985, Physician). Table 1 summarizes these underlying reasons for physicians' use of laboratory tests.

Ordering for the Physician's Own Benefit. Physicians' ordering of laboratory tests may be influenced by financial considerations, preferred style of practice, the image or reputation to which the physicians aspire, and concern over potential malpractice litigation.

1. Financial Reasons. As described more fully in the following section of this report, financial incentives may affect physicians' ordering of medical services. Especially with fee-for-service payment, physicians historically have had direct financial incentives to order and bill for laboratory tests. To the extent that fee-for-service payment systems have been based on charges for technological services,

TABLE 1

Why Physicians Order Laboratory Tests

I. Ordering for the physician's own benefit.

1. Financial benefit
2. Practice style
3. Reputation
4. Defensive medicine

II. Ordering for the patient's benefit.

1. Clinical needs
2. Patient demand
3. Patient finances
4. Patient convenience
5. Patient characteristics

III. Ordering for society's benefit.

which generally exceed the cost of providing service and thereby yield a profit, there is an incentive to order laboratory tests (Showstack, Blumberg, Schwartz, 1979). This incentive is even more powerful when physicians own major pieces of equipment, such as in-office laboratories, or when physicians are part-owners of either independent, commercial laboratories or hospitals with laboratories (Schroeder, Showstack, 1978 Financial; Myers, Schroeder, 1981; Relman, 1980). The incentive to order laboratory tests may not apply equally to all tests, however. Physicians perceive different (and sometimes incorrect) profitability for different tests and may behave differently if a test is perceived as profitable or unprofitable (Epstein, Krock, McNeil, 1984). Similarly, physicians' financial benefits from test-ordering are likely to vary with the type of third-party coverage involved. Physicians perceive this difference in the profitability of tests with different coverage, and Medicaid coverage is generally perceived to be unprofitable for physicians (Epstein, Krock, McNeil, 1984).

2. Practice Style. Physicians adopt different styles of practice as a result of their attitudes,

values, tastes, experience and habits (Williams, Eisenberg, Pascal et al 1982; Hardwick, Vertinsky, Barth et al, 1975; Eisenberg, 1979; Eisenberg, 1985 Physician). They prefer to care for certain types of patients with certain kinds of clinical problems, and to use certain preferred diagnostic tests.

3. Reputation. Physicians may aspire to chosen reputations and may use laboratory testing to build and promote those reputations. For instance, a physician who tends to use more laboratory tests than other physicians may be viewed as especially thorough, committed, and caring. A physician who uses fewer tests may be considered parsimonious, cost-conscious, and efficient. The practice ethos that is established by clinical leadership and peer pressure, especially in formally organized practices such as in health maintenance organizations or in residency training programs, can have an important effect on use of laboratory tests (Freeborn, Baer, Greenlick et al, 1972; Williams, Eisenberg, Pascale et al, 1982).

Physicians' concern about their reputations may affect their response to financial incentives. This

may help to explain why, when the fee-for-service system provides direct financial incentives for physicians to order laboratory tests, use of laboratory testing has not grown even more rapidly than it has. Physicians may not have pushed the use of tests out to what is, in some sense, the maximum. A variety of factors, including physicians' concern for their reputations, may serve as a brake on unnecessary laboratory testing (Pauly, 1980).

4. Defensive Medicine. Physicians may order laboratory tests in an attempt to prevent or defend against malpractice suits. Test results may be used to substantiate clinical decisions, to demonstrate that patient problems are being addressed, or to meet some implicit standard of care. A recent survey reports that 20 percent of physicians claim to have increased the use of tests or treatment procedures for defensive medicine purposes (Am. Med. News, 1985). Despite the fact that defensive medicine seems to be offered frequently by the medical community as a reason for overuse of tests, there is little empirical

evidence to support or refute a conclusion about the use of laboratory testing for defensive medicine purposes (Tancredi, Barondess, 1978). Given rapid changes in the medico-legal environment, there is certainly a need for careful up-to-date study of the practice of defensive medicine.

Ordering for the Patient's Benefit. Use of laboratory tests for patients can be influenced not only by clinical needs, but also by patient demand, patient finances, patient convenience, and patient characteristics.

1. Clinical Needs. The most important influence on physicians' use of laboratory tests is clinical: the prevention, diagnosis, and treatment of disease. Clinical medicine is rarely straightforward, however, and the ambiguity of the clinical situation and the physician's level of confidence about the situation may influence utilization. The desire for more clinical information to reduce uncertainty or to clarify ambiguous clinical situations will encourage greater use of laboratory tests. Although their work

does not focus on laboratory testing, Wennberg and his colleagues conclude that clinical uncertainty is a major factor causing variation in physician practices (Wennberg, Gittelsohn, 1982).

2. Patient Demand. Patients themselves may demand tests. A survey of patients in fee-for-service and HMO primary care practices revealed that nearly one-third requested tests (Murphy, Goroll, 1985). For two-thirds of patients who had upper gastrointestinal x-ray series, their expectation that the test would be done was an important factor in its being ordered (Marton, Sox, Wasson et al, 1980). Other research suggests that patients are more satisfied with their care and their physicians when diagnostic tests are ordered, even when the tests have little clinical value in their cases (Myers, Schroeder, 1981).

3. Patient Finances. Prices that patients pay may influence physicians' use of services. Although the evidence is mixed, patients' insurance coverage and out-of-pocket costs may affect use of tests directly or indirectly through physician visit rates (Epstein, Krock, McNeil, 1984; Marquis, 1982; Eisenberg, 1985 Physician). Concern for the patient's

pocketbook may not always be altruistic, however, since patients who spend less on testing may have more to spend on physicians' fees (Pauly, 1980).

4. Patient Convenience. Although there is little empirical evidence, physicians may consider patients' convenience in ordering laboratory tests (Rose, Abel-Smith, 1972). This is considered to be a major factor promoting the growth of physician office-based laboratories. With pending over-supply of physicians and already excess numbers in some specialties and some regions of the U.S., convenience in the form of "one-stop shopping" for patients is seen as a way to attract and keep patients.

5. Patient Characteristics. Physician behavior can be affected by a variety of patient characteristics, including social class, age, sex, income, physical appearance, and ethnic background (Eisenberg, 1979). Although these demographic characteristics may seem to affect physicians' use of services, they actually may reflect other socioeconomic or clinical factors, such as the patient's likelihood of having certain diseases, the patient's ability to pay, or the degree to which

physicians would like to have these patients in their practices (Eisenberg, 1985 Physician).

Ordering for Society's Benefit. It is unclear if and how much physicians consider the general social good in their clinical decisions. For example, present perceptions of the social good may encourage careful husbanding of limited resources because of widespread concern about the cost of medical care. Medical professional organizations, educators, third party payors, business and the media have all attempted to attract physicians' attention to the perceived need to limit medical care expenditures. This goal often conflicts directly with physicians' commitments to their individual patients and to their own economic goals. Moreover, with conventional insurance coverage, the cost to the patient of additional services is often much below their resource cost or price. Hence, taking the full cost of those services into account puts the physician in conflict with his obligation to consider the welfare of the individual patient.

The amount of medical care that is "appropriate" depends on whether the standard of appropriateness is

a medical or societal one. The economist might suggest that medical services are socially appropriate only if the opportunity cost of the resources consumed is less than or equal to their value to patients. In contrast, a medical definition of "appropriate" might include any service with a positive expected contribution to the patient's health status, regardless of the opportunity cost of the resources consumed in providing it (Woodward, Warren-Boulton, 1984). The ethical dilemmas posed by these conflicts will become increasingly important as cost containment pressures increase. At present, the impact of social considerations on physicians' use of laboratory tests is probably small compared to considerations of patient and physician benefit.

3. Financial Incentives and Physicians' Ordering of Services

Given the complex set of forces that influence physicians' prescription of medical services, if Medicare payment to physicians changes, how will the

change affect the use of laboratory tests? This question, which is the focus of this report, incorporates the assumption that economic factors represent at least one of several factors that affect physicians' medical decision-making. In this section, we address two related questions: 1) what is the evidence that medical decision-making is influenced by different systems and levels of payment, and 2) how significant is the change in decision making?

Financial incentives theoretically can influence physician decisions in six ways:

1. Physicians can alter the actual volume or intensity of services provided.
2. Physicians can substitute services; for instance, they can substitute one test for another or can substitute technological services, such as laboratory tests, for cognitive and "hands-on" services, and vice versa.
3. Physicians can perform services at one site (e.g., in-office laboratory) instead of another (e.g., independent commercial laboratory).

4. Physicians can change the label for their services. This concept has been described as "procinflation" (for "procedure inflation") or "category creep", and recognizes that the category or service for which a physician bills can be changed in order to increase payment, even though the actual service has not changed. This label change also includes unbundling of services, that is, billing separately for services (such as an office visit and routine lab test) that previously were billed together (Kirchner, 1979).
5. Physicians can modify the fees that they charge for services.
6. Physicians can promote or discourage patient access, such as by accepting or refusing Medicare assignment.

Each of these six different effects may have different implications for cost, quality of care, and access.

Physician Supply, Target Income, and Induced Demand. One approach to explaining the link between physician decision-making and finances involves two concepts: target income and induced demand. Some economists have proposed that physicians set a desired income level for themselves. This targeted income level may take into account desired leisure time as well as income in determining how much time the physician will spend practicing (Woodward, Warren-Boulton, 1984).

Having set a target income level, physicians then attempt to meet that goal either by satisfying some of society's unmet demand for medical care or by creating new demand. Demand can be created at the level of the individual doctor and patient by recommending or ordering services, such as surgery, follow-up visits, laboratory tests, and radiologic procedures. Two other ways for a doctor to achieve a targeted income include 1) changing the amount that the physician charges for services, and 2) altering the reported complexity or mix of services for which the physician bills (Etheredge, Juba, 1985). The actual volume or complexity of services that are

provided to the patient need not change for the charge or reported complexity and volume to change.

Since the great majority of physicians' services, in both public and private insurances, are still handled via the fee-for-service (FFS) system, physicians' and patients' reponses to this payment system should be explored at this point. In order to understand the basis for forecasting how physicians' behavior might change if fee levels were altered, or if FFS were replaced by some alternative system, it will be useful to consider some alternative models of physician behavior under this system.

The most general economic model of physician behavior is one in which physicians get utility from money income and leisure time, but are constrained in maximizing this utility by patient demand and by the technical production process; that is, by the need for inputs such as physician and aide time if output is to be produced.

Let us consider a market in which the fee level for specific procedures are fixed (for example, by an Economic Index to limit increases to the cost of providing care). Let us also assume that the additional cost to the physicians for providing some

service, which include both his outlay cost for personnel and materials and the subjective cost of his own time which he must withdraw from leisure or other types of care, rise as the output he supplies rises. Then each physician's "supply curve" will rise with price, as will the aggregate supply curve to the market. This means that the quantity of services that physicians would like to produce will rise with the price paid for them. Set the price Medicare pays very low, and physicians will find other things to do. Set the price very high, and physicians will increase the amount they would like to supply.

With a demand constraint, however, desired supply is not the only influence on use. Use is also limited by what patients are willing to accept, and that willingness may be affected not only by the price level itself (when patients pay something out of pocket), but also by patents' perceptions of convenience, usefulness, and comfort.

A simple diagram to show what can happen as the price the physician receives is varied is presented at Figure 1, where SS' is the supply curve and demand is set at D_0 (assumed to be independent of price in this

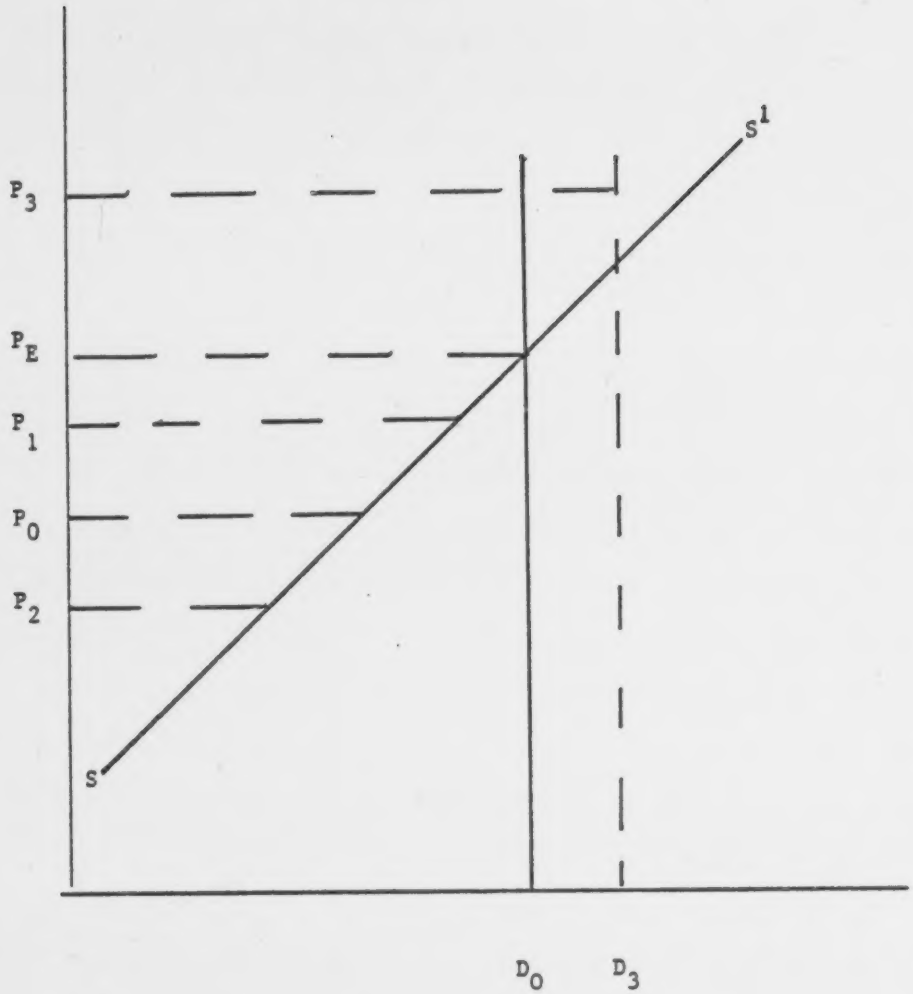

Figure 1

example). If price is initially at P_0, increasing it to P_1 will increase the quantity observed. Reduce price to P_2 and the quantity observed will decrease. But that is not the only possibility. If the price is initially above P_E, the price at which supply equals demand, the quantity observed will be determined by what patients want to buy, not by what physicians want to sell. If the quantity demanded does not depend on the price the physician receives (because of virtually complete insurance coverage), and if that price is reduced from P_3 to P_E, no effect on quantity will occur. If higher prices do affect the quantity demanded, then reducing the price the physician gets will also make care cheaper for the patient, and use will rise. Depending on whether the demand constraint or the supply constraint is binding, reducing the price can cause volume to rise, fall, or stay the same.

It may, however, not be appropriate to assume that demand by patients is fixed, independent of physician incentives. The "target income" or "inducement" theory of physician behavior rests on two postulates:

1. Physicians have the power to affect the

demand they face; this power comes from their role in providing advice to patients on their medical care consumption.

2. Physicians <u>will</u> alter the content of this advice in response to financial rewards.

As Reinhardt (1985) has recently noted, from a formal viewpoint inducement models are quite similar to models of conventional firm behavior in which firm-level demand can be affected by advertising. In most inducement models, however, the "cost" of shifting demand is not thought to be an explicit cost -- newspaper ads, reminder notes sent to patients, etc. -- but rather is modelled as a subjective cost to the physician. The cost is the disutility (or discomfort) the physician feels when he responds to the lure of money by changing the content of his advice away from the advice that represents his unbiased clinical judgment (Pauly, 1980). A more recent theoretical development has emphasized that demand creation is also constrained (especially in the long run) by the ability of the suspicious patient to switch physicians (Dranove, 1984).

While the assumption that physicians can shift demand seems eminently plausible, the empirical evidence that they do so to a significant extent is mixed at best. Some of the evidence that supports the target income and induced demand theories derives from studies of the relationship between physician supply and the cost and volume of services. If physicians can create demand to generate income, then the total volume of services provided by all physicians combined should increase as the number of physicians per capita rises, even without a decrease in the price of their services. The results of these studies are of special interest in light of anticipated large increases in the supply of physicians.

A critical review of such studies of induced demand concludes that the results of numerous studies are inconclusive (Wilensky, Rossiter, 1983). Methodological problems undermine the validity of some studies and definitional problems obscure the results of others. For instance, a statistical relationship between physicians' supply and volume of services in a geographic region is not sufficient evidence to imply causality; other factors, such as the incidence of

illness or insurance coverage, may affect volume of services as well (Wilensky, Rossiter, 1983). Even if a causal relationship between physician supply and volume of services does exist, the high volume of services could reflect high demand by residents of an area, which attracts physicians to the area, rather than induced demand.

To address the relationship between volume of services and physician supply, Wilensky and Rossiter (1983) attempted to assess the magnitude of physician-induced demand using data from 1977-78 National Medical Care Expenditure Survery. Their analysis suggests that patients' medical characteristics and out-of-pocket costs are more important in explaining variations in the volume of medical services than is physician supply. Physician supply had a statistically significant but small effect on the volume of ambulatory visits and expenditures for ambulatory care, but was not significant in explaining variation in surgical rates or total health care expenditures.

Wilensky and Rossiter (1983) also distinguish between physician-induced demand and

physician-initiated demand. They suggest that physicians' responsibility includes initiating demand insofar as they act as patients' agents and recommend services that a well-informed patient would want. In contrast, induced demand would occur only when physicians recommend services for which patients would not willingly pay if they knew as much as the physicians. Wilensky and Rossiter estimate that approximately half of ambulatory care expenditures and 90 percent of total health care expenditures are initiated by physicians. The data from their study suggest that physician-induced demand is not large, occurring more in ambulatory care and ancillary services than in inpatient care or patient visits.

Another approach to detecting inducement is to look at the relationship between the physician stock and the physician fee level. Here again, empirical results are mixed, and Pauly and Satterthwaite have found that, for office visits to primary care physicians, apparent inducement associated with more physicians actually reflects a decrease in the ease with which consumers can compare physicians' prices and quality levels, not a shift in aggregate demand.

Somewhat suprisingly, the investigation of inducement most germane to this paper -- how volume varies when the price of one or a few services is altered -- has not been pursued strongly, as will be indicated below.

In any case, inducement theories, like the conventional theory, have ambiguous predictions about the impact of fee levels on volume. Figure 1 helps to illustrate why this is so, and how an inducement model differs from a conventional model. Suppose D_0 represents the demand that would be observed in the absence of inducement; it is the demand which reflects unbiased advice. For price levels below P_E, no inducement will occur, since there is "excess demand" even without inducement. Increase price in this range, and quantity will rise.

When prices are above P_E, inducement would be possible, and volume could be increased to a level in excess of that shown by D_0. But there is still ambiguity in what the theory says about the effects of price changes on volume. Consider, for example, cutting a fee that was initially at P_3 with associated "induced" quantity D_3. Since the difference between the price received and the minimum price needed to

bring forth supply is a measure of the addition to profit from inducing more demand, and since the marginal profit falls when price falls, one might expect there to be less inducement and therefore less volume. But if price falls, that also reduces provider income, and at lower income levels, some physicians may be more willing to tolerate departing from their best judgment in order to make money. This behavior - increasing volume in order to offset a fall in unit price -- is the common-sense meaning of the term "target income;" in economic jargon, it reflects the fact that adherence to preferred practice style is a normal good -- a good which is desired in smaller quantities when income falls and that this "income effect" may be quite strong..

So even at prices above P_E, and even when the patient pays nothing out of pocket, an increase in volume can accompany a fee cut -- but so can a decrease in volume. One may conjecture that the income effect is likely to be less important when the service in question forms a smaller part of a provider's total income, or when the fee levels for other procedures are increased.

Finally, if patients pay nothing out of packet or ignore what they do pay, these patients may not only be willing but eager to accept more tests after a fall in fee levels for the tests. If the only way to make treatment of the patient more profitable is to permit additional profitable tests, then one can view those tests as part of a quiet conspiracy on the part of physician and patient to maintain the physician's income from Medicare, despite an attempt by Medicare to reduce it. Even if the patient finds the tests inconvenient -- and so would have resisted them at the higher price level -- acceptance of an inconvenient test may be preferable to finding a new physician or losing the advantage of acceptance of assignment by one's current physician.

Therefore, a price cut in payment for laboratory tests with constant payment for physician services theoretically can lead to either an increase or a decrease in test volume. The empirical literature reviewed later in this report finds some natural experiments in which volume rose following a cut in fee levels, but if offers little guidance on the effect of a change in fees for overall testing alone,

given the small share of laboratory fees in total payments. For purposes of discussion, in what follows, we will usually assume that laboratory service fee levels and volume will be positively related, basing this assumption on the observation that the great bulk of tests are provided in settings in which they do not constitute the major source of physician's income. Nevertheless, the ambiguity of theory and the scarcity of empirical evidence should be kept in mind.

Payment Rates and The Volume of Services: Despite the weakness of evidence that physicians induce demand, when payment rates for medical services are changed or limited, physicians appear to provide altered volumes of services. The bulk of the empirical evidence comes from natural experiments in which the whole range of physician fees (including laboratory tests, office visits, and in-hospital procedures) was affected.For example, when prices were frozen during the Economic Stabilization Program (ESP) in 1971, the number of services provided to California Medicare patients increased, resulting in greater expenditures than if services had not increased. The

increases in volume of services occurred in office and hospital visits and in ancillary services. Moreover, when ESP ended, physicians raised their charges by 23 percent and reduced volume by as much as nine percent for general practitioners (Hadley, 1979; Gabel, Rice, 1985). Similar results were found for California Medicaid patients during and after ESP. Some of the increase in volume during ESP could have been due to unbundling of services that were billed previously as a package (e.g., office visit with routine laboratory tests) (Gabel, Rice, 1985).

In another natural experiment, Medicare payment rates were adjusted in Colorado, with urban rates declining and rural rates increasing (Rice, McCall, 1982). For physicians whose payment rates declined, their provision of more intensive services rose; for those whose payment rates increased, the intensity of services provided decreased. However, the change in volume did not fully offset the change in fees so that gross physician revenues were altered. A one percent decline in payment rate was associated with a 0.61 percent rise in intensity of medical services, a 0.15 percent increase in intensity of surgical services, and a 0.52 percent increase in laboratory services.

There is, however, other empirical evidence consistent with a reduction in volume of services provided accompanying lower payment rates. For example, physician willingness to accept Medicaid patients and to render services to them tends to be lower when state Medicaid fee levels are low relative to fees received for other patients (Cromwell, Mitchell and Sloan, 1978).

Physicians may not only add or subtract the services they provide but also may substitute services in response to financial incentives such as selective changes in payment rates. For instance, if payment rates for technological services, such as laboratory tests, are set high relative to cost and if payment rates for cognitive services, such as office visits, are set low, then physicians may substitute laboratory tests for office visit time. Instead of taking more time with patients to ask about history or bleeding problems or ease of bruising, why not order several coagulation studies? Schroeder and Showstack have demonstrated that physicians can triple their net incomes by performing and billing for office-based

tests even though total patient volume may decline by as much as 15 percent due to the substitution (Schroeder, Showstack, 1978 Financial).

The empirical evidence for substitution is mixed, however. In part, this may be due to the fact that it is difficult to distinguish between increased volume of technological services observed over time and unbundling of services formerly billed as a unit (e.g., an office visit with laboratory tests previously billed together, but separated later into multiple charges.). Rice and McCall found that Colorado physicians did not significantly adjust their laboratory test ordering in response to changes in payment rates for office visits (Rice, McCall, 1982). On the other hand, Brook et al found that when the use of certain injectable drugs was constrained, physicians replaced the drugs with other services for which they could bill (Brook, Williams, Rolph, 1978, Controlling; Brook, Williams, Rolph, 1978, Use). Danzon also reported from the Rand Health Insurance Experiment that physicians substitute laboratory tests for time spent with patients if payment rates for office visits are reduced (Danzon, Manning, Marquis,

1984; Marquis, 1982; Danzon, 1980; Danzon, Manning, Marquis, 1983).

Our ability to understand physicians' responses to changes in price for their services is limited by the fact that these studies were natural experiments, uncontrolled for other intervening effects. There is a second reason why the existing empirical data makes it difficult to predict the effect of changes in the payment for laboratory tests on physicians' utilization of these tests; there is no conclusive empirical evidence about the impact of prices for laboratory services (either for hospital-, commercial-, or physician-provided laboratory tests) relative to the prices for other services. If the price of laboratory tests that the physician performs in the office were raised, the physician could substitute a greater volume of tests for other medical services. If reducing fees across the board increases the volume of laboratory tests, does the same result hold for a price reduction that falls only on tests including those provided by the physician? The conventional presumption is that, to the contrary, physicians would reduce their volume of these

services, since they become relatively less lucrative (possibly substituting other more profitable services for them). That conjecture, however, usually is based on the notion that physician time is an input to all services and is distributed by the physician, to some extent, based on financial rewards. Laboratory tests do not, however, consume an appreciable amount of physician time. Therefore, it is unclear whether a decrease only in the price of laboratory tests performed in the office would result in a compensatory increase in volume or a substitution of other more profitable services for the tests.

We hypothesize that changes (e.g., a decline) in rates could either increase or decrease test volume depending on the circumstances. We propose that a reduction in payment rates for laboratory tests will increase volume if rates are already high, and if the reduction applies to: 1) all or a large segment of the patient population, 2) all or most other services, and 3) the patient's portion of the rate. In contrast, a reduction in payment will decrease volume of testing if rates are already low and the reduction in rates applies to 1) a small segment of the patient

population, 2) only some services (e.g., just in-office testing), and 3) patients do not benefit directly from the reduction (e.g., they pay nothing out of pocket before or after the reduction).

Specialty Payment Differentials and Laboratory Testing. It has been proposed that differences in payment levels among physician specialties may affect laboratory testing. Generalists tend to be paid less than specialists, and physicians who rely on "cognitive, hands on care" (e.g. internists) tend to be paid less than physicians who rely more on technology (e.g., surgeons). It has been demonstrated that physicians are paid up to 10 times more per unit time for performing procedures than for counseling, teaching, consoling or examining a patient (Almy, 1981).

Specialists tend to use more laboratory tests than generalists when caring for the same types of patients (Eisenberg, Nicklin, 1981; Greenwald, Peterson, Garrison et al, 1984). However, there is no data to help distinguish whether payment levels or other factors, such as type or length of training, are most important in explaining differences in practice

style between generalists and specialists. For this reason (as well as because of the unclear relationship between price and volume of tests when other prices are held constant), it is not clear whether there would be an immediate effect on laboratory testing by reducing payment differentials between generalists and specialists. In the long term, reducing those payment differentials may encourage more physicians-in-training to choose generalist over specialist careers and thereby reduce laboratory testing. It seems, however, that all levels of payment, not just those for laboratory testing should be considered if the goal is to encourage physicians' entry into particular career pathways.

To conclude, evidence suggests that physicians do respond to financial incentives but that the response is often unpredictable. Although the evidence is spotty, physicians can respond in a variety of ways that range from changing billing codes to discouraging access for selected patients. Moreover, the financial incentives to order laboratory testing are related not only to payment for the tests themselves but also to payment for physician

services. While the volume of services does seem to respond to payment levels, the direction and magnitude of the response will also be governed by factors such as the proportion of the physicians' practice that is affected, whether fees for all services are changed, the patient's portion of the fee, and the ability to substitute other services

4. Possible Payment Systems for Physicians and Laboratory Tests

If financial incentives influence physicians' prescription of medical services, including laboratory tests, then the amount and manner in which physicians are paid has important effects on the utilization and cost of medical care.

Physicians are paid similarly for "physician services" and for laboratory testing services in the Medicare program. Physician services, such as office visits and performance of procedures, presently are purchased through a system that reflects prevailing charges in the community but is limited by the

Medicare Economic Index to restrain fee increases. Laboratory tests also are purchased by Medicare through a system that reflects prevailing fees but is constrained to limit expenditures per test.

Usual, Customary, and Reasonable (UCR) Charge. The Medicare program uses a variation of the "usual, customary, and reasonable" (UCR) charge system. Also known as a fee screen or profile system, this method of determining payment has been employed by various Blue Shield programs since the 1950s (Showstack, Blumberg, Schwartz et al, 1979). It is the most commonly used method for determining physician payment. Under UCR, the insurer pays the least of 1) the physician's actual charge, 2) the physician's "usual" charge for a service (the profile), 3) the "customary" charge of similar physicians in a geographic area (usually limited by a "screen", e.g., 75th percentile of charges), or 4) a "reasonable" charge for exceptional or unprecedented circumstances.

The use of UCR was largely experimental until the new Medicare program adopted it in 1966. The enabling legislation required the programs that administer physician payments for Medicare to:

> "assure that, where payment...is on a charge basis, such charge will be reasonable and not higher than the charge applicable for a comparable service and under comparable circumstances to the policy holders and subscribers... In determining the reasonable charge...there shall be taken into consideration the physician's customary charge for similar services...as well as the prevailing charges in the locality for similar services" (Showstack, Blumberg, Schwartz et al; citing Social Security Amendments of 1965).

As such, Medicare payment for physician services is based on a UCR methodology, but with some modification. Medicare payment for physician services (through the Medicare Part B program) is based upon actual, customary and prevailing charges. The "reasonable" charge is the lowest of these three kinds of charges. Medicare pays 80 percent of the reasonable charge and the beneficiary is responsible for the remaining 20 percent (coinsurance). The Medicare physician payment system is termed "CPR" for

"customary, prevailing and reasonable". The physician's "customary" charge for a service is defined as the physician's median charge for that service during the previous year. Services are categorized for Medicare billing purposes based on CPT-4 billing terminology. The "prevailing" charge is defined as the 75th percentile of customary charges for a specific procedure by physicians in that specialty and geographic area during the previous year (Burney, Hickman, Paradise et al, 1984; Rice, 1983). However, since 1975 increases in the reasonable fee have been limited by the Medicare Economic Index, which is based on inflation in the general economy and medical office costs (Holohan, 1980 Physician). Therefore, for most services the reasonable fee no longer reflects the 75th percentile of customary charges in the area but is substantially lower.

Physicians have two options for payment under Medicare: to "accept assignment" or "not accept assignment." If physicians accept assignment, they agree to accept the Medicare reasonable payment for services (plus the usual 20 percent patient coinsurance and any outstanding deductible, both of

which must be paid by the patient) as payment in full. Therefore, if they accept assignment, physicians will receive payment directly from Medicare carriers but cannot charge the patient any amount in excess of this payment (except the deductible and coinsurance payments). If physicians choose not to accept assignment, they must seek payment from patients, including the Medicare reasonable charge (which under non-assignment is not paid to the physician but is paid directly to patients after subtracting the coinsurance and deductible). In addition, the physician who does not accept assignment can charge the patient more than the prevailing fee, so he is not limited by Medicare's definition of a reasonable fee as the lowest of actual, customary and prevailing. However, no matter what the actual fee, the patient whose physician does not accept assignment will only be reimbursed by Medicare for the previaling fee less coinsurance and deductible amounts. Thus, a physician accepting assignment does not risk patient default on payment but does have a ceiling on payment levels. The physician who does not accept assignment risks default on payment by patients but has no limit

on charge amounts. Until 1984 all physicians could choose whether or not to accept assignment on a claim-by-claim basis, whereas most Blue Shield plans have required that physicians decide whether or not to be "participating physicians" as a blanket decision, in which case assignment would be accepted for all Blue Shield claims.

The Deficit Reduction Act of July 1, 1984 (DEFRA) established a 15-month freeze on customary and prevailing charges for physician services, including a freeze on billed ("actual") charges for "non-participating" physicians. The Deficit Reduction Act also prohibited physician billing for laboratory services not performed in the physician's office (Burney, Hickman, Paradise et at, 1984).

The physicians who elect to become participating physicians agree to accept assignment for all of their claims for all of their Medicare patients. DEFRA legislation introduced the concept of "participating" physicians into Medicare Part B. Although non-participating physicians can still accept assignment on a case-by-case basis, physicians who agreed to participate would be required to accept

assignment always. Participating physicians are exempt from the freeze on actual billed charges. Originally, they were promised that they would be paid more after the initial freeze if they accepted assignment; however, the freeze on charges and payments to physicians may be extended. "Non-participating physicians," those who accept assignment on a claim-by-claim basis, also may care for Medicare patients and bill for that care, but their actual charges are subject to the freeze. Sanctions for raising charges during the freeze range from financial penalties to exclusion from the Medicare program for up to 5 years (CCH para. 3190:1217-5).

Outpatient laboratory tests are purchased by Medicare according to a modified UCR methodology as well. Before the Deficit Reduction Act of 1984, physicians could bill for laboratory services whether or not they performed or supervised the service. If the test was performed outside the physician's office, the physician would be paid 80 percent of the lesser of the actual charge or the reasonable charge plus a charge for specimen collection and handling. The

Deficit Reduction Act now limits physician payment for tests that are sent to an outside laboratory to the specimen collection, handling and test interpretation. Therefore, physicians are now precluded from billing Medicare for laboratory tests performed in any independent laboratory. The maximum payment is $3 per patient encounter (for specimen collection and handling) if the test is performed by an independent or hospital laboratory (CCH para. 3330:1281). Payment for the test itself is handled separately.

According to DEFRA, laboratory tests originating in physicians' offices or independent laboratories now will be paid at the lesser of actual charge or according to a fee schedule set at 60 percent of the prevailing charge levels (based on the fee screen for the previous year in that region). These fees will be adjusted annually for changes in the Consumer Price Index (unlike physicians' fees, the prevailing rates for laboratory tests have not been constrained by the Medicare Economic Index). For hospital laboratories, when they are serving hospital outpatients, the payment will be the lesser of the actual charge or 62

percent of prevailing rates. Hospital outpatients are those patients who use the hospital outpatient clinics or emergency rooms. Tests performed by hospital laboratories for other patients will be paid at the independent laboratory rate. Tests commonly included in an automated panel will be paid as a panel when the sum of the reasonable charges for the separately billed tests exceeds the prevailing rate for the panel. In general, if three or more tests on a panel are billed individually, only the prevailing rate for the panel will be paid (CCH para. 3132:1119-20).

Since DEFRA, the coinsurance and deductible for laboratory tests have been waived if the physician accepts assignment, and the physician is paid the lower of either submitted charges or 100 percent of the fee schedule rate. If assignment is not accepted, Medicare will reimburse the patient 80 percent of the fee schedule (after the deductible is met), and the physician may charge the patient his customary charge. Of course, patients have an incentive to use physicians who accept assingment since they will not have to pay the deductible or coinsurance for laboratory tests. Hospital and independent

laboratories are required to accept assignment, and the patient's coinsurance and deductible payment are waived for these tests as well.

Although this fee schedule system of paying for laboratory tests (with the fee schedules differing from carrier to carrier according to prevailing fees) has only been in operation since 1984, HCFA is currently requesting proposals to evaluate demonstration projects using competitive bidding for outpatient laboratory testing. The current system is to be in effect only until June 30, 1987. After that date, if no new legislation is passed (such as regionalized competitive bidding), a nationwide fee schedule is to be established, at least for independent and physician laboratories.

Fee Schedule. Fee schedules establish fixed maximum payment levels for specific services. They are used by workers' compensation and private insurance programs, by 25 Medicaid programs (as of 1979) (Holohan, 1984, Physician), and by health insurance programs in Canada and Western Europe (Showstack, Blumberg, Schwartz et al, 1979). The basis for determining payment often is a relative

value scale (RVS) schedule, which places values on specific services relative to a standard service. These relative values, often expressed in units, are transformed into payment amounts by applying a dollar conversion figure. For instance, if the value of an office visit is 2 units and an EKG is 3, then by applying a conversion factor of $10, payments for the office visit and EKG will be $20 and $30, respectively. Some fee schedules that are based on relative value scales established by professional organizations have been examined for potential illegality because of the possibility of price-fixing (Jencks, Dobson 1985).

Fee schedules, whether set by RVS or not, are often adjusted periodically by analyzing physician charges and by adding or deleting services. The trend has been to add procedures, partly by refining definitions and distinguishing among categories of services. For instance, the number of procedures listed in the California RVS increased from 2100 in 1964 to 5500 in 1974. In 1964, there were nine categories of office visits; by 1974, the number of categories had grown to 15 (Showstack, Blumberg, Schwartz et al, 1979).

CPR and Fee Schedules. These two payment systems are both fee-for-service systems; that is, physicians are paid on the basis of individual services provided to beneficiaries. Because of the way that the Medicare CPR system has evolved, some consider it a fee schedule payment system rather than a true UCR payment system (Burney, Hickman, Paradise et al, 1984). By placing ceilings on increases in prevailing rates, the system has become "a series of specialty-specific local fee schedules set at the economic index-constrained prevailing charge levels" (Washington Report, 1985). In 1982, 83.1 percent of assigned claims and 85.6 percent of unassigned claims were reduced because resonable charges were less than actual charges. This was due, in part, to the limitations on increases in the prevailing fee imposed by the Medicare Economic Index, which increased 65 percent from 1975 - 1982 while the Consumer Price Index increased 80 percent (Etheredge L, 1984; Committee on Finance, U.S. Senate, et al, 1983). Therefore, the difference between CPR and fee schedules has become blurred.

As fee-for-service systems, CPR and fee schedules share similar problems. First, they

encourage fee increases if no limits are placed on the rate at which price levels are permitted to rise. Since profiles and charges are used in computing payment under CPR and often in updating payment screens under fee screens, there is an incentive for physicians to increase their fees in order to raise their own profiles (and also the prevailing profiles in the community) (Showstack, Blumberg, Schwartz et al, 1979; Kirchner, 1979). In addition, there is an incentive for physicians new to an area to set their fees high initially, as well as for new technologies to be priced high at their introduction (Roe, 1981; Schroeder, Showstack, 1979; Zollinger, 1982). It is for the above reasons that UCR has been called a "boondoggle" (Roe, 1981). It was also for these reasons that increases in prevailing charges were tied to the Medicare Economic Index in 1975 and subsequently prohibited in 1984. Limits on increases, however, may discourage physicians from accepting assignment, choosing instead to charge patients a greater amount than Medicare will pay.

Second, fee-for-service systems permit two means of altering income by changing the way services are

reported. The overall trend is to describe with increasing precision the nature of procedures or service provided. The first, "category creep" or "procinflation," is the upgrading of services for billing purposes. For instance, there can be as many as 15 classifications of office visits. By redefining an office visit as slightly more complex or by providing slightly more complex care, physicians can increase their remuneration (Showstack, Blumberg, Schwartz et al 1979). The second means of changing the way services are reported is termed "unbundling." When unbundling, physicians bill in an a la carte fashion, charging for several procedures rather than one global one (Showstack, Blumberg, Schwartz et al 1979; Kirchner, 1979; Zollinger, 1982). For example, a physician who may have traditionally performed a urinalysis as a part of every comprehensive visit may decide to bill Medicare for the urinalysis as well as for the office visit. Commonly, the sum of charges for the parts is greater than the charge for the whole. There is evidence that both unbundling and procedure creep occur (Holohan, Scanlon, Hadley et al, 1980, The effect; Gabel, Rice 1985; Danzon, Manning, Marquis 1984; Rice, McCall, 1982; Rice, 1983).

Third, fee-for-service payment historically has sustained historical differences between payments to generalists and specialists and between payments for cognitive and technological care. The relationship of fees to cost or time commitment has only begun to be assessed (Hsaio, Stason, 1979; Kirchner, 1984). In addition, probably the majority of services now available, especially in the technological realm, has been added to the physician's armamentarium since the use of fee-for-service payment by third party payors became widespread. Therefore, their initial prevailing fees can be set at a high level, whereas payment for older services will be limited by traditional fee schedules and constrained even more by the Medicare Economic Index.

However, it is important to note that these inter-specialty differences may have been less important in Medicare's payment for outpatient laboratory testing. Since 1978 carriers have been advised that "the respective customary charges of all physicians and approved laboratories for that test should be comingled in the computation of the prevailing charge in that locality for the test." Therefore, Medicare does not officially

recognize specialty differences but maintains a single prevailing charge for laboratory services for each area. Furthermore, these prevailing fees for laboratory tests have not been subject to the limits of the Medicare Economic Index, at least since 1978 (Report of the Laboratory Task Force, 1984).

Packaging. One alternative to fee-for-service systems is to package services, that is, to pay a lump-sum amount for all inpatient and outpatient care (capitation) or for subsets of care, such as an episode of care. For instance, surgeons have long provided "packaged care." Their fees generally include pre- and post-surgical physician care, as well as the surgical fee itself. Maternity care is another example of packaged care.

The most all-encompassing physician payment package is capitation, the payment of a fixed amount per beneficiary to a physician or organization that would be responsible for all physician and other medical services during a specific time period. Medicare now pays for physicians' services on a capitation basis through HMOs and other qualified competitive medical plans. Physicians are not prepaid

directly by Medicare, however, but are paid through contracts with HMOs. HMOs are paid up to 95 percent of a prospectively determined rate that is adjusted for variations within the Medicare population. Another potential packaging plan -- although it strains the meaning of the term somewhat -- is described as "regional capitation" or "geographic capitation." In this scheme, Medicare would pay an intermediary a capitated fee for coverage of Medicare eligibles and the intermediary would be able to devise its own delivery or payment scheme, be it HMO, fee for service or any other arrangement.

Other ways of packaging of services also are under consideration. For instance, package payment could be made for:

1. Physician services for inpatient care only (payment per admission).
2. Physician services for inpatient and outpatient care, plus outpatient ancillary services (payment per episode of care).
3. Physician services for outpatient visits and outpatient ancillary services only (payment by episode or by capitation).

4. Physician services for inpatient and outpatient care, outpatient ancillaries and hospital care (payment by capitation).

Depending on what party receives the payment (individual physician, groups of physicians, hospital, or other organization such as a carrier), physicians can be paid by service, by package of service, by patient, or can be paid a salary. Payments by service or package of service can be set by contracting according to a fee schedule or a UCR fee screen system. Thus, even within a capitation scheme, physicians can be paid on a fee-for-service basis, although the incentives may be modified somewhat. Given past experience with fee-for-service, this suggests that controls on utilization would be essential if overall fees are set near current levels.

There is little evidence about the effect of packaged physicians' payment on their practice patterns, other than the research on HMOs and that currently underway regarding physician DRGs (see below). However, one experiment sheds some light on the effects of packaged payment to physicians for care

for hospitalized patients. Physicians at ten Pennsylvania hospitals agreed to a single payment for their services for Blue Shield patients hospitalized with one of 24 diagnoses (Markel, 1980). Payment levels were based on historical utilization and price information for each diagnosis. Overall, length of hospital stay declined three percent, although the impact was highly variable among hospitals.

DRGs are under consideration as one method for determining physician payment levels for a hospital package. Early results suggest that DRGs may be more feasible for paying surgeons since the current payments for physician services in surgical DRGs seem to be relatively homogenous for uncomplicated cases (Washington Report, 1985). Medical DRGs pose a problem, however, since these physician payments currently are highly variable. With physician DRGs, assignment would probably have to be mandatory (or at least consistent for all of a physician's patients), since optional assignment would encourage physicians to refuse assignment on high cost cases in order to bill the patient for the higher cost.

Packaging episodes of care, such as a hospital stay, may not be a flawless solution to physician payment. The cost containment goals may be circumvented if "admissions are induced or split, services are unbundled from the package price, costs are transferred to outpatient settings, and/or interns and residents are substituted for physicians" (Burney, Hickman, Paradise et al, 1984). In addition, physician services for hospitalized patients account for only 64 percent of Medicare Part B costs. The remaining 36 percent of costs would not be constrained under a hospital episode package plan (Burney, Hickman, Paradise et al, 1984). Another weakness of the physician payment package by admission is that it would place certain physicians, particularly those caring for Medicare patients, at risk of widely varying payment for time spent, since systems such as DRGs explain less of the variance in physician payment for medical cases. While DRGs do explain more of the variance in surgical payment, this greater homogeneity in surgical charges (which reflect both the relative homogenity of services provided to these patients and the traditional packaged charges of surgeons) suggests

that less would be gained by institutionalizing a DRG-based payment scheme for surgeons.

5. Site of Laboratory Testing

Regardless of the payment system, physicians have a practical monopoly on the ordering of laboratory tests. Except for a few tests that have recently become available for home testing by patients, a physician must order laboratory tests for patients. In doing so, they influence where those tests will be performed. In general, tests can be conducted at three sites: hospital laboratories, independent laboratories, and physicians' offices. In this section, we will 1) define each type of laboratory, using Medicare definitions, 2) review Medicare payment mechanisms for laboratory tests as they relate to site of testing, 3) describe laboratory quality regulation by site, and 4) evaluate the "boom" in physician office testing.

Types of Laboratories. The three types of laboratories (Table 2) have peculiar characteristics

Table 2

Medicare Definitions of Outpatient Clinical Laboratory Testing Sites

Hospital Laboratory:		A hospital-based or affiliated laboratory providing services to hospital outpatients, that is, outpatients registered at the hospital
Independent Laboratory:		A hospital-based or affiliated laboratory providing services to non-hospital outpatients (e.g., tests referred from another facility)
	or,	A laboratory independent of a consulting or attending physician and/or a hospital
	or,	A laboratory maintained by a physician or group of physicians that during any calendar year performs tests on 100 or more specimens in any particular category on referral from other physicians not in the same practice
Physician Office Lab:		A laboratory maintained by a physician or group of physicians for performing tests on physicians' own patients
	and,	If tests also are accepted on referral, no more than 99 referral specimens in any one category can be processed in any one calendar year

Sources: CCH paragraph 3132:1109-1111; paragraph 3330:1280

with important effects on physicians' decisions about where to have diagnostic testing performed.

Traditionally, testing was principally performed in hospital laboratories. Hospital laboratories provide testing services for inpatients, hospital outpatients (patients using hospital ambulatory care services, such as clinics or emergency rooms), and non-hospital patients. Laboratory services for hospital inpatients are included in the DRG rates, although some related physician services may be billed to Part B (e.g., the pathologist's fee for interpreting the test, or the physician's fee for performing a procedure such as thoracentesis to obtain body fluids for testing). Even if a laboratory is physically situated apart from a hospital, it is considered to be a hospital laboratory if it is operated or supervised by a hospital and serves hospital inpatients or hospital outpatients.

Under Medicare regulations, however, services provided by hospital laboratories for non-hospital patients are reimbursed as if the laboratories were independent, not hospital, laboratories (National Intelligence Report, 1984). The distinction can be

important, since it determines the rate of payment. Similarly, Part B charges for laboratory services from independent laboratories are to be disallowed by carriers for patients in an inpatient setting. Those charges are to be paid by the hospitals and reimbursed under DRG rates.

The second major site of service is independent laboratories, which are defined as laboratories that are independent of an attending or consulting physician's office and independent of a hospital (Although, as noted above, hospital laboratories may be reimbursed as independent laboratories when serving hospital outpatients).* Independent laboratories accept specimens for testing from outside physicians or hospital laboratories. Sometimes independent laboratories maintain specimen collection stations at hospitals, clinics, or other sites. Independent

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*An attending physician is a physician who has primary responsibility for patient care; a consulting physician provides such services as history-taking, patient examination, etc., in order to provide a clinical opinion to the attending physician, or performs a procedure at the request of the attending physician.

laboratories are usually commercial and for-profit, and increasingly are owned and managed by national (or multinational) firms. Although local laboratories owned by these large corporations generally offer the full range of commonly-ordered tests, some are also regional or national referral centers for less common tests. Both hospital laboratories and independent laboratories can offer unique laboratory medicine services. They can be reference laboratories, providing the "gold standard" for validating results and procedures. Hospital laboratories, especially those located in major medical centers, often offer the full range of clinical testing, including tests that are used infrequently or are especially costly. As such, these laboratories act as community resources, providing "back-up" and regional services.

The third type of laboratory, one which has especially important implications for systems of paying doctors, is the physician office laboratory. These laboratories are used for physicians' own patients. The office laboratory may service a single physician or multiple physicians who practice in a group. Medicare also permits testing by physician

office laboratories for outside (non-group) physicians' patients, but this outside testing is limited to fewer than 100 specimens in any particular category in any calendar year as long as the physician or group has not entered into any agreement regarding testing (CCH para. 3330: 1279). If a physician office laboratory accepts more than the limited number of specimens, advertises that testing is provided for outside physicians' patients, or provides testing according to formal agreement (e.g., contract), then it is treated as an independent laboratory.

Physician office testing is not new but until recently has been limited to a relatively few commonly-performed tests. They included urinalyses; blood cell counts; Gram, acid-fast bacillus and stool stains; throat cultures for streptococcal infection; and pregnancy tests. In general, these tests are performed by nursing or other physician office staff and not by specially trained technicians. With the advent of sophisticated, small clinical chemistry equipment, physician office testing has begun to encompass a much larger range of services. In addition, some tests traditionally performed in many

offices, such as urine and throat cultures, can now be carried out with reasonable accuracy using new rapid office diagnostic tests, thus potentially reducing the staff time required and the need for incubation equipment.

One trade newsletter has estimated that the total volume of 6.2 billion laboratory tests performed yearly in the United States is still dominated by hospital laboratories, with 3.4 billion tests yearly. The volume of testing by independent laboratories was estimated to be 1.8 billion, with 900 million tests per year in physicians' offices and the remaining 90 million in "other" locations (Biomedical Business International, 1984).

Medicare Payment for Laboratory Services. As described earlier, since July 1, 1984, payment for outpatient laboratory tests for Medicare beneficiaries has been determined by areawide fee schedules regardless of where the test is performed (CCH paragraph 3330:1276). Although the payment system is definitionally closer to and operates like a UCR system, it has been labeled a fee schedule because it

sets fixed maximum payment levels. Under the new "fee schedule," laboratories will be paid the lesser of the fee schedule amount or the actual charge for the test (CCH paragraph 3330:1270) (Table 3). Whenever actual charges exceed the fee schedule, payment made at the lesser of the fee schedule or actual charge will approximate a true fee schedule as actual charges approach fee schedule levels.

For independent laboratories and physician office laboratories (including hospital laboratories when they act as independent laboratories by providing services to non-hospital patients), the fee schedule is set at 60 percent of prevailing charges for the area for the year, adjusted annually according to the Consumer Price Index* (CCH paragraph 3330:1276). For hospital laboratories, the fee schedule is set at 62 percent of prevailing charges (CCH paragraph 3330:1276). Therefore, for those laboratories whose

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*Note that prevailing charges are calculated as the 75th percentile of customary charges (i.e., the level below which 75 percent of charges fall), weighted by frequency, for physicians and independent laboratories.

Table 3

Medicare Payment for Outpatient Laboratory Services by Site

	Hospital	Independent	Physician Office
Fee Schedule	62% of prevailing charges	60% of prevailing charges	60% of prevailing charges
Assignment	Mandatory	Mandatory	Physician discretion
Payment Amount			
• Assignment	..100% of fee schedule or actual charge, whichever is less		
• Non-assignment	N/A	N/A	80% of fee schedule or actual charge, whichever is less
Out-of-Pocket (Patient pay)	No deductible or coinsurance	No deductible or coinsurance	Deductible and coinsurance required for unassigned claims
Medicare payment to:	Laboratory	Laboratory	Assignment: Physician Non-assignment: Patient

Sources: CCH paragraph 3330:1278-1279

charge is greater than 60 or 62 percent of the 75th percentile of customary charges, the Medicare payment will be less than their charge. For those whose charge is less than the 60 or 62 percent of the fee schedule, the Medicare payment will be equal to their actual charge.

Independent and hospital laboratories must accept assignment in order to be paid by Medicare, and patients do not pay deductibles or coinsurance (CCH para. 3330:1278) (Table 3). However, laboratory services provided through physician office laboratories may be paid on an assigned or unassigned basis (CCH paragragh 3330:1277). If unassigned, payment to the patient is 80 percent of whichever is less: the 60 percent fee schedule or the actual charge. In addition to paying the 20 percent coinsurance and the difference between the actual charge and the fee schedule, the patient must meet the yearly Part B deductible (CCH paragraph 3330:1270).

Beginning on July 1, 1987, the laboratory fee schedule is required to be established on a national basis for independent and physician office laboratory services only. If the legislation is not changed,

hospital laboratories may revert to reasonable cost basis for determining payment for outpatient laboratory services (CCH paragraph 3330:1277). The return to cost-based reimbursement was seen as a potential remedy for hospital laboratories in case the combination of prospective payment for inpatient care and national fee schedules for outpatient care proves to be too onerous.

Thus, physicians can be paid according to two methods simultaneously for the same patient's care. For instance, if a patient who has an office visit also has a test performed in the physician's office laboratory, the physician will bill 1) for the office visit according to the Medicare CPR fee screen and 2) for the laboratory test according to the fee schedule.

Prior to the Budget Reconciliation Act of 1984, physicians could bill for laboratory tests that were performed by independent laboratories. The laboratory would charge physicians for the tests, then physicians would bill Medicare or the patients (depending on whether the doctor accepted assignment), often for an amount greater than the laboratory charged the physician. The costs of collecting and handling the

specimens and physician interpretation of test results were the justification for the markup. On the other hand, if the laboratory billed Medicare directly, the payment would have been the same as if the laboratory had billed the patient (limited by the prevailing fees for the test). The General Accounting Office study examined this practice of marking-up charges and resulted in the elimination of the physician markup on independent laboratory services (CCH paragraph 3190:1208). Thus, physicians are no longer permitted to bill for tests performed in independent laboratories. Physicians are permitted to charge one $3 specimen collection and handling fee per patient encounter regardless of how many specimens are collected (CCH paragraph 3330:1277). This does not prohibit physicians from marking up charges for laboratory tests performed in the physician's office, within the limits of the fee schedule described above.

A ruling from the U.S. Court of Appeals for the Third Circuit, filed April 30, 1985, in the case of The United States of America versus A. Alvin Greber, has important implications for a potential problem that is raised by the limits on physicians' ability to

charge for tests sent to an outside laboratory. Laboratories that want to attract physicians to use their services might be tempted to pay the physicians a fee which could be described as a consultative fee but which would esentially be a kickback. The Court ruled in this case of a cardiac monitoring service that paid referring doctors a "compensation for services" that "if the payments were intended to induce the physician to use [the] services, the statute (P.L. 95-142, 91 Stat. 1183(1977)) was violated, even if the payments were also intended to compensate for professional services." If this ruling is upheld (assuming it is heard by the Supreme Court), restrictions on kickbacks from laboratories will be even more restrictive than in the past.

Laboratory Quality Regulation. Independent and hospital laboratories are subject to quality regulation by the Health Care Financing Administration under both the original Medicare enabling legislation enacted in 1965 and the Clinical Laboratory Improvement Act enacted in 1967 (Foster, 1984). Physician office laboratories are exempt from federal quality assurance regulation.

Federal regulation of laboratories is directed at:

1. Laboratory personnel - Requirements for personnel working in laboratories include educational and experience requirements for hiring and career advancement.

2. Quality control - These regulations include surveillance of equipment, instruments, methods, reagents and results; adequacy of facilities, equipment and devices; requirements for reagents; maintenance of standard operating procedure manuals; availability of quality control records; solicitation safeguards; and standardized recordkeeping (Foster, 1984).

3. Proficiency testing - Laboratories must participate in externally administered proficiency testing programs. Participation includes processing specimens submitted by the outside proficiency testing agency, which then will determine whether or not the laboratory has met the accuracy standards (Foster, 1984).

States license laboratories as well. Most states (39 as of 1984) regulate hospital laboratories,

requiring them to meet minimal performance standards (Foster, 1984). Of the remaining states, nine set specific requirements regarding specific tests, most commonly for two screening tests that often are legally mandated: syphilis serology (often required for marriage licenses) and newborn phenylketonuria (PKU) tests (Foster, 1984). As of 1984, over half of the states regulated independent laboratories. As with hospital laboratory regulation, of those states that do not regulate independent laboratories, many have set standards for specific tests (Foster, 1984).

Unlike the federal government, a growing number of states regulate physician office laboratories. As of 1985, five states enforce personnel requirements for physician office laboratories and four require proficiency testing. Twenty states require licensure to perform specific tests, such as prenatal or premarital syphilis serology tests (American Society of Internal Medicine, 1985). For instance, as of 1984 Maryland began to require physicians to undergo laboratory proficiency testing. Pennsylvania and California regulate physician office laboratories extensively, including personnel, equipment, facility,

reporting, and proficiency testing requirements (American Society of Internal Medicine, 1985; Grayson, 1984). In Pennsylvania a three-tiered system for regulating medical office laboratories has been in place since 1977. For simple tests (e.g. urinalyses), described as "Level I," doctors need only pay a small fee and pledge to honor general quality control requirements. For slightly more complicated tests (e.g. blood glucose), which are described as "Level II," physicians' offices must undergo proficiency testing. For Level III testing, which includes many clinical chemistries, office laboratories in Pennsylvania are subject to periodic, unannounced inspections in addition to proficiency testing (Washington Report, 1985).

Massachusetts recently began enforcement of a law that requires physician office laboratories serving more than two physicians to meet the same standards as independent laboratories (American Society of Internal Medicine, 1985). The Massachusetts action reflects a growing tendency to define "physician office laboratory" in terms of the number of physicians participating. For example,

Arizona, Maryland, New York and Wyoming define a physician office laboratory as serving only one physician, whereas Florida and Michigan permit as many as five physicians to participate in one office laboratory (American Society of Internal Medicine, 1985). As such, in some states, group practice laboratories are defined as independent laboratories and thereby subject to more rigorous state regulation (American Society of Internal Medicine, 1985).

Although most regulation of physician-office laboratories has been left to the states, federal agencies are concerned about the quality of in-office laboratory testing. For example, in 1985 the Centers for Disease Control plans to stimulate states and universities to develop programs to assist the improvement of microbiological testing in physician-office laboratories through voluntary training and continuing education. Organizations such as the National Committee for Clinical Laboratory Standards (NCCLS) help promote quality of laboratory testing through development of standards and publication of "how to" materials for laboratory directors and technicians.

Why is regulation of quality in physician office laboratories increasing? The American Society of Internal Medicine (American Society of Internal Medicine, 1985) posits four reasons:

1. Shift from inpatient to outpatient testing. Since the Medicare DRG Prospective Payment System encourages preadmission and other outpatient testing in physician offices, there will be increasing interest in regulating the quality and cost of that testing.

2. New classes of laboratories. Groups of physicians who are not in practice together sometimes establish and operate laboratories for their own patients. Since these are technically neither independent laboratories nor physician office laboratories, they often are not subject to regulation, even though they potentially may be responsible for a large amount of testing.

3. Shift to physician office laboratories. As physician office laboratory equipment becomes more affordable and convenient, increasing amounts of laboratory testing will shift from hospital and

independent laboratories to physician offices. As the proportion of testing conducted in office laboratories grows, pressure to regulate quality and cost will increase as well.

4. Constitutent pressures. Professional laboratorians have an interest in maintaining high standards for laboratory testing, no matter where it occurs. Likewise, those who operate highly-regulated laboratories, such as independent laboratories, and who pay the added costs of abiding by standards established by regulation will apply pressure for regulation of all competing laboratories. Obviously, interests other than that of the quality of testing play a role in this pressure for universal regulation.

Do physician office laboratories provide testing of adequate quality? This is a highly charged and controversial issue, on which there is plenty of strong opinion and little empirical evidence. There are anecdotes about high school students or other unskilled workers working part-time performing physician office tests, as well as stories of neglected quality control and inadequate storage of reagents.

Some physicians and laboratorians assert that the accuracy of testing provided in hospital and independent laboratories often exceeds by far the accuracy required for clinical decision-making. They question whether physician laboratories need to be measured according to this perhaps unnecessarily rigorous yardstick. Is it better quality testing to provide test results to the third or fourth significant figure when the physician will only use results to the first or second? Is there a difference for the clinician (or the patient) between a glucose of 300 and 310?

Manufacturers of new laboratory technology aimed at the physician's office emphasize the accuracy and reliability of test results from their equipment, as well as built-in, pre-packaged quality control. They imply (and sometimes state) that tests can be performed on this new technology without the intervention or direction of trained laboratory professionals. Not surprisingly, professional laboratorians are quick to assert the need for qualified personnel to direct and process tests (Fischer 1985). One alternative includes consulting

arrangements between physician offices and independent laboratory profesisonals relating especially to setting up office labs, interpreting regulations, and maintaining quality (Statland BE. A new 1985).

There is some evidence that physician office laboratories do not maintain high levels of quality control and that they provide less accurate results than licensed laboratories. A 1983 survey of California physicians who have office laboratories found that less than one-third had formal quality control procedures (Grayson RT, 1984). When tested for proficiency, 80 percent of the test results from office laboratories were significantly less accurate than those reported from regulated laboratories. (These are likely to have been "statistically significant" differences; whether they were also "clinically significant" cannot be said). For some tests, the results were reportedly so inaccurate that analysis of a normal specimen could yield a substantially abnormal result. Therefore, while the equipment may be capable of satisfactory performance, its use in physicians' offices may not always take advantage of these capabilities.

Coming Boom in Physician Office Labs? Tests available through physician office laboratories, which historically have been limited to a few diagnostic tests that could be carried out with a microscope, a certrifuge and a few reagents, are expanding rapidly due to technological advances in instrumentation. Physician office laboratories have been targeted as an growing market by instrumentation manufacturers. Research and development activities have emphasized four areas: automated multi-test analyzers, test kits, home diagnostics, and management consulting.

The first manufacturing thrust has been to provide automated multi-test analyzers for blood. As many as 30 different tests can now be performed by one machine in a physician's office. These include not only blood glucose tests and electrolyte panels that have been available for several years, but also coagulation studies and assays of hormone, enzyme, and drug levels (Von Stein, 1985; Shiffler, 1984). Analyzers can cost $2500 to $10,000, depending in part on the number of tests provided, not including the cost of labor and supplies (Shiffler, 1984).

A second emphasis of the manufacturers has been the design of convenient test kits (for instance, for

viral influenza, throat culture or blood glucose levels) that can be used without instrumentation (Von Stein, 1985; Shiffler, 1984; The Medical Letter, 1985). Multi-test kits are in the works. Disposable devices for detecting chemical or biological substances also are under development. When available, they may be applied to infectious diseases or drug detection and monitoring (Cassak D, 1984, New horizons).

The third product line development relates to a fourth site for laboratory testing (in addition to hospital, independent and physicians' office laboratories): the home (Murnick, 1985; Shiffler, 1984). Although these tests are designed for use in the home, many will be provided only through physician prescription. Already available (without prescription) are pregnancy tests and stool occult blood testing. Urine glucose and blood glucose tests for diabetic patients have been available since the 1950s and 1970s, respectively (Murnick, 1985). Patients on continuous ambulatory peritoneal dialysis soon may have available a home test kit for early detection of peritonitis (Murnick, 1985). Home test

kits are under development for monitoring theophylline levels for chronic lung disease (including asthma) patients, warfarin levels for patients on anticoagulant therapy, and diphenylhydantoin levels for epileptic patients (Murnick, 1985). Currently available, but with improvements under development, are tests for home-use to detect urinary tract infections (Murnick, 1985).

A fourth line of development relates to linkages between full capacity laboratories and decentralized physician office laboratories. Hospital laboratories are setting up computerized consultative services, offering quality control, staffing, equipment maintenance, record-keeping, reporting and accounting services to physicians who have office laboratories. Direct computer networks will tie automated office instruments to central laboratories. As laboratory testing moves "closer to the patient" through office testing (Hardwick, Morrison, Cassidy et al, 1985), independent laboratories also may develop similar consultative services.

Why do physicians want to operate their own laboratories (Table 4)? First, physicians are seeking

Table 4

The Pros and Cons of Opening a Physician Office Laboratory

Arguments For:	Arguments Against:
1. Added Income	1. Questionable quality
2. Patient convenience	2. Potentially a costly hassle
3. Increasingly affordable and profitable	3. Confusing and rapidly changing equipment market
	4. Alternative of investing in independent lab may be more attractive

new sources of patient-related income. Other sources of income have been restricted or are declining, because of changes such as Medicare's elimination of physician markups on tests performed by independent laboratories (Hardwick, Morrison, Cassidy, 1985). As physicians observe limitations on fees for professional services, they may be motivated to provide more services directly. For example, in Rhode Island, where physicians were prohibited from billing any patient for laboratory tests furnished by an independent laboratory even before 1984, 35 percent of all non-hospital testing is performed in physicians' offices (HCFA, 1985). Moreover, due to a variety of factors, physicians are experiencing declining numbers of office visits and thus potentially declining revenue from office visits and related services, potentially releasing time to supervise an office lab. According to one estimate, the average weekly number of office visits per physician dropped nearly 20 percent during the 1970s and early 1980s (Von Stein, 1985).

Second, in-office laboratories are seen as a patient convenience and a means of improving quality of care (Cassak, 1984 New horizons). The value of

in-office testing lies in part in its ability to provide more immediate results to physicians and patients. The goal is quick turnaround of test results. No longer would patients necessarily have to be sent home or to a laboratory and then brought back for a repeat visit to review test results. Laboratory testing is seen, at least in part, as a patient service that will enhance not only quality of care, but also patient satisfaction (Cassak D, 1984 New Horizons). A survey of group practices by the Medical Group Management Association revealed that the foremost reported reasons for establishing or expanding office laboratories were patient convenience and quality of care (personal communication, M.A. Krill, Medical Group Management Assoc.).

Third, office laboratories are more justifiable, affordable, and lucrative for group practices than for single physician offices, largely because of the volume of testing made possible by the larger patient base (Von Stein, 1985; Shiffler, 1984; Cassak, 1984, The changing; Cassak, 1984 New horizons). With larger volumes, the variable cost of providing each test probably declines and the average cost is even more

likely to fall. Therefore, when prices or payment are static or rise, profit per test increases with volume. It has been estimated that over 80 percent of group practices have laboratories and that these laboratories can provide as much as 30 percent of practice income (Lyle, 1976; Von Stein, 1985; Nakamura, 1985). Group practices have grown in number and size over the last decade*. The American Group Practice Association estimates that there are now at least 18,000 group practices, with a total of 150,000 physicians. The American Medical Associations's estimates are lower, suggesting that there are 15,000 group practices of three or more physicians. The Medical Group Management Association reports a membership of 3400 groups, representing an estimated 70,000 physicians (personal communication M.A. Krill).

Why would physicians <u>not</u> want office laboratories? First, physicians may be concerned that

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*A group practice is defined as a legal entity in which expenses for facilities, personnel, and equipment are shared and arrangements for allocation of income are made.

the quality of testing may not be adequate (Cassak, 1984, The changing; Cassak, 1984, New horizons). At worst, inaccurate or misleading results may endanger patients' health. Even if the consequences for the patient are not serious, the physician's level of clinical uncertainty rises, patients' confidence in and regard for the physician may suffer, and if sued, physicians may not be able to defend their decisions.

Second, in-office testing may be seen as a costly hassle. In addition to the initial laboratory equipment expenditure, costs can be substantial for space, personnel, reagents and supplies as well. Given increasingly restricted fee schedules governing payment for laboratory tests, physicians may conclude that smaller per-test profits may not be worth the investment and the trouble (Cassak, 1984, New horizons). Especially when plans for Medicare physician payment reforms are rumored, physicians may be less likely to add to their fixed costs (Cassak, 1984, New horizons). Quality assessment, quality control, and formal licensure and regulation add work and paperwork, the costs of which can be significant. In hospital laboratories, tests that are run for

quality control purposes can account for 30 percent of all tests (Tydeman, Morrison, Hardwick et al, 1982). At two independent laboratories, quality control was estimated to account for 20-30 percent of the cost of performing tests. In addition, physicians generally have little experience hiring and supervising qualified laboratory technicians.

Third, the confusing array of new multi-test automated laboratory equipment itself may discourage physicians from investing in office laboratories. Although some instruments are available now, physicians must wonder whether to wait for subsequent models, which are still in development but already much ballyhooed. Why buy this equipment now, when the next one will be bigger, provide more accurate results, and take care of its own quality control?

Fourth, it may be more profitable for physicians to invest in an independent laboratory to which they send their patients' specimens. Because of the novelty of physician investment in commercial, independent laboratories, few states have issued regulations and few courts have handed down rulings governing the degree to which physicians may profit

from the services that a laboratory provides to their own patients. In California, limited physician partnerships in laboratories have been ruled legal by the state attorney general (National Intelligence Report, 1984). Physician partners, however, cannot be "credited" according to the volume of testing referred to the laboratory. It is not known how many laboratories are "owned" by physicians.

In conclusion, the "boom" in physician office laboratories may not materialize to the extent that manufacturers envision, especially if 1) concerns about quality and accuracy of testing cannot be overcome and 2) payment for services continues to constrict. Larger group practices will be more likely to establish substantial laboratories than will small practices. To the extent that the number of group practices with in-office laboratories increases, there will be greater pressure to regulate in-office laboratories as vigorously as hospital and independent laboratories are now. Alternative strategies to in-office testing, such as starting an independent laboratory with other group practices, may seem more attractive. Greater regulation and reduced financial

incentives will discourage smaller practices from starting or expanding their own laboratories.

If office laboratories continue to proliferate rapidly, what will this mean for large independent and hospital laboratories? Some would predict that office laboratories will add excess capacity and eventually increase total costs for laboratory testing. A recent study by Boston Biomedical Consultants suggests that the independent and hospital laboratories will lose up to 19 percent of the market to physician offices and other medical care settings (Health Policy Week, 1985). They predict that in-office tests will increase by 14 percent and independent laboratory testing will decline by 6 percent. More importantly, they also predict that the number of independent and hospital labs will fall by nearly 25 percent (from 5500 to 4000) by 1990. The surviving laboratories will cut costs, emphasize marketing and provide additional services to in-office physicians.

6. Costing of Laboratory Tests

What is the cost of various kinds of laboratory tests? This is an important question for payment

policy since a doctor's profit (or the laboratory's profit) will depend not only on the level of payment but also on the cost of production. Unfortunately, there probably is no such thing as a "true" cost of production since cost may differ depending on the circumstances.

Accountants generally classify costs dichotomously as fixed or variable, and as direct or indirect. Fixed costs are those that generally do not vary with volume of testing (within certain limits, of course). An example is the purchase of equipment that is used to perform the actual chemical analyses. In contrast to fixed costs, variable costs do vary with the volume of testing. An example is the purchase of reagents; the more tests performed, the more reagents are needed. The sum of fixed and variable costs is the total cost of producing the tests. In addition to being fixed or variable, costs may be direct or indirect. Direct costs are those that are directly related to production, such as technician time spent in handling the specimen. Indirect costs (in an accounting sense) are indirectly related to production and include such items as the laboratory supervisor's time.

Weinstein and Pearlman, in the process of analyzing the cost-effectiveness of automated multichannel chemistry analyzers, described fixed and variable costs as follows:

> Among the costs that are typically considered to be fixed, that is, independent of the number of samples analyzed, are equipment costs, insurance, maintenance, laboratory supervision, and overhead (including administration, space, utilities, etc.). Variable costs, that is, those roughly proportional to the number of samples analyzed, include reagents, and consumables and supplies... A major economic effect of automation in the laboratory, generally, and of multichannel analyzers, in particular, has been to transform costs that had previously been variable into fixed ones... The result is that increasing automation becomes economically more attractive at high volumes of use (Weinstein, Pearlman, 1981).

An important component of the cost of producing a laboratory test is direct labor, that is, the amount

of personnel time required to perform the test, exclusive of supervisory or other support personnel. Weinstein and Pearlman reflect on the difficulties of classifying direct labor cost, which accounts for 40-60 percent of total direct costs, into fixed and variable categories:

> Direct labor, the most important economic element, is not yet reflected in this typology of costs. Labor costs for technician and technologist time do not fall neatly into either category. Some aspects such as sample collection, coding and preparation, and reporting of results are more variable than fixed. Other aspects, especially sample processing and analysis, are more nearly variable if tests are performed manually, but more nearly fixed if automated equipment is used. An additional fixed labor cost with automated equipment is training of technicians. Thus, a major impact of automation has been to transform many labor costs from variable to fixed...(Weinstein, Pearlman, 1984).

The concepts of fixed and variable costs, as well direct and indirect costs, are used largely in planning and budgetary control, including cost control (Conn, Aller, Lundberg, 1985). For example, if volume declines, by how much would variable costs be cut? How large a decline in volume would be needed to bring about a cut in fixed costs, such as supervisory time?

Tydeman and colleagues use these accounting approaches to answer a different question: what has been the impact of new technology on laboratory cost (Tydeman, Morrison, Kasap et al 1983, The cost; Tydeman, Morrison, Cassidy et al, 1983, Analyzing)? They hypothesize that as a laboratory becomes more automated, the variable costs of providing laboratory testing would decline. Using ten years of data from a hospital laboratory, they partition total variable costs into three components: cost of inputs (including labor, consumables, etc.), productivity or efficiency (full time equivalent personnel or other inputs per workload unit) and complexity of testing (workload units per test). Their results suggest that as the hospital laboratory became more automated: 1) the relative proportion of input costs represented by

consumables (reagents and supplies) increased significantly, 2) the cost per minute of personnel time increased; and 3) the complexity of tests performed decreased; that is, the number of workload units required to produce a test declined. Overall, using constant dollars, the total cost per test increased by only 21 percent between 1971 and 1981, while the index of capital stock (a measure of technology*) increased more than three-fold. Tydeman and colleagues highlight a secondary potential effect of automation, which has been described by Weinstein and Pearlman as well: induced costs (Tydeman, Morrison, Cassidy, Hardwick, 1983, Analyzing; Tydeman, Morrison, Kasap, 1983, The cost; Weinstein, Pearlman, 1981). They suggest that were it not for the availability and lower costs of automated testing, some tests would not be performed as frequently. The costs of these extra tests are termed induced costs.

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*The Tydeman et al index of capital stock is based on annual estimates of capital stock (constant 1971 dollars) given depreciation of existing technology and new acquisitions.

Tydeman et al found that over the 10-year period studied, the number of tests ordered per acute care admission increased not only due to the availability of more types of tests, changes in case mix, and increased malpractice concerns, but also due to the induced costs of repeated tests or tests that were required to follow-up abnormal results. In one study of hospital admission screening, use of a multichannel analyzer, a blood analyzer that can perform multiple tests simultaneously on one specimen, led to a 78 percent increase in the number of other tests performed, a 64 percent increase in other laboratory costs, and a 25 percent increase in the number of consultations (Durbridge et al, 1976). Citing the observation that these induced costs can account for half of total laboratory costs, they suggest that the greatest economic impact of automated multichannel technologies may lie in their induced costs.

This cost information can be used to understand the circumstances under which investments in laboratories will be made and under which laboratories will be used. For these purposes, the key calculations are the average and marginal costs per

test. The average cost includes both fixed and variable costs, and is the total cost of providing a set of tests divided by the number of tests. In contrast, marginal costs are the costs of producing one more laboratory test. Marginal costs are roughly the same as variable costs for the last unit produced - in this case, the additional cost of producing an additional laboratory test (except where volume increases are so large as to require increases in fixed costs as well) .

While physicians might use a comparison of average price paid with average cost to determine whether to invest in an in-office laboratory, average cost depends upon the volume of tests they anticipate performing. The physician can ask whether projected revenues for this volume of testing will cover the investment and production costs. In contrast to this decision about whether to establish a laboratory, the decision to order one more laboratory test depends on the marginal cost of the additional test compared to what will be paid (also considering how much the patient will benefit and other professional influences on test-ordering described earlier in this report).

Statland (Statland, 1985) estimated the marginal cost of producing a laboratory test in a physician's office versus in a hospital laboratory. He found that the marginal cost in the physician's office laboratory was $1.25-$2.00 and the average cost was between $3.50 and $5.72, depending on the number of tests performed (assuming 30 tests/physician/day and estimated costs for a range of one to four physicians using the laboratory).* The marginal and average costs in the hospital were $0.44 and $1.12 respectively (assuming that 3000 tests would be performed each day and that all specimens would be collected in-house). At Medicare rates, the physician would be paid an average of $11 (60 percent fee schedule), while the hospital would be paid $11.40 (62 percent fee schedule) for the test. However, if the hospital laboratory were to perform tests on specimens collected in the

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*It is not clear what physician specialty, types of tests, or types of patients were assumed. Presumably, since the cost of producing tests would vary widely depending on these factors, the generalizability of these estimates is limited.

physician's office and thus pay transportation and other service costs, the marginal cost per test may approximate that found in the four-physician office laboratory.

Although numerous untested assumptions underlie this analysis, it does represent a unique attempt to compare the costs and profitability of hospital versus physician office laboratory testing. In doing so, it reveals the potentially substantial profits of laboratory testing and illuminates the economies of scale of laboratory testing.

Economies of scale, that is, the decline in average costs associated with increased volume, are thought to be due to spreading fixed costs, which do not vary with volume, over a larger number of units produced. However, even variable costs may decrease if there is efficiency gained by performing more tests (e.g., some semi-variable costs such as quality control can be spread out over more tests, or laboratory personnel may be able to perform two tests simultaneously in less than twice the time required to perform one test). One consequence of falling average costs is that the cost of the inputs to produce one

more laboratory test (the marginal cost) will be less than the average cost. In Statland's example, estimated average direct costs in the physician's laboratory ranged between $3.50 and $5.72 per test, depending on the number and type of tests performed, while marginal costs ranged between $1.25 and $2.00. Likewise, estimated average direct cost and marginal cost per test in the hospital laboratory amounted to $1.12 and $0.44, respectively (Statland, 1985). Based on these estimates, current Medicare fees would represent mark-ups of about 100-200 percent for tests performed in the physicians' office.

It is likely that the cost of tests depends not only on volume but also on how they are produced (manual versus automated, etc.). Fineberg has found this to be the case for the performance of the multichannel analyzer at three hospitals (Fineberg HV, 1981). Overall costs per specimen were $4.31 (in 1980 dollars) at one hospital, $6.84 at another and $6.21 at a third. This meant that the costs per determination on the panel were $0.87, $0.72 and $0.29. The ratio of fixed to variable costs at these three hospitals ranged from about 1:1 to 3:1.

Fineberg concluded that different patterns of organization and staffing have differing implications for the incremental costs of adding or dropping determinations from a sample.

Similar variation in cost occurs according to the method of analysis for non-automated tests as well. For instance, for one in-office test --for theophylline drug levels-- manual testing costs approximately $15 per test, as compared to $2 - $4 for automated testing. Nonetheless, the prevailing fee reported for outpatient therapeutic drug monitoring is about $30 per test regardless of how the test is performed. Even with a 60 percent fee schedule payment by Medicare, there is potential profit to be made even by using the method with the higher marginal cost (Biomed. Bus. Internat., 1985, Clinical). At the other end of the spectrum, one new autoanalyzer that is priced around $90,000 for the basic unit can produce 400 to 600 tests per hour at a cost reported to be $0.12 to $0.15 per test (Biomedical Business International, 1985, Clinical).

One must be skeptical, however, of marginal cost figures reported by manufacturers, who want to portray

the equipment as offering profits to physicians who purchase it. While the College of American Pathologists' Workload Study offers standardized measures of labor input and the price of reagents is readily available, these estimates of average cost probably serve more as industry standards than as estimates of marginal cost.

Both of these cost concepts- average cost and marginal cost- are important for payment policy, but for different reasons. For a firm or physician to be willing to supply any quantity of some output, price must at least equal average cost. For independent services paid according to a fee schedule, marginal revenue is the same as price. If price is below average cost, then total revenues will be less than total cost. This will impose a financial loss on the provider, something that cannot be sustained indefinitely. In other words, marginal revenue (the revenue from selling one more unit of output), which is equal to price, generally must at least equal average cost when marginal revenue is fixed by a fee schedule.

"Loss leaders" are a special case. These are tests for which price is less than average cost

but that can lead to greater volume of other physicians' services. In this case, the true marginal revenue is the price of the test plus the net price of the "induced" services.

In contrast to the relatively simple relationship between price and average cost of laboratory tests (which affects the decision to engage in the business of testing), the relationship between price and marginal cost affects financial incentives differently at different volumes of testing. The difference between price and marginal cost is marginal profit. As long as price exceeds marginal cost, it will increase profits to furnish more tests (once the decision has been made to furnish some tests).

Here is the paradox of optimal pricing with economies of scale. One wants price to cover average cost, so that the provider is willing to incur the start-up, or fixed, costs necessary to provide the tests. But one also wants to establish prices that are "incentive neutral" with regard to ordering more tests. That is, one does not want price to exceed marginal costs, at least not by very much, because the profit acts as a financial incentive to order one more

test when the person who orders the test also makes the profit on the test. With economies of scale, however, marginal cost is always less than average cost so that it is impossible to have a price that is incentive neutral at the margin and still induce positive amounts of output. There seems to be no way to avoid financial incentives for over-provision and still encourage providers to produce at all.

As such, there is not a great deal to be gained by discovering what average cost is if the goal is to set price just equal to it. Incentives will be warped if price equals average cost, if it is ten percent over, or even a bit under the average cost (so long as it still exceeds the marginal cost). Paying more than average cost provides even greater incentives to proliferate tests at the margin, although we do not know how much more testing would be done.

For these reasons, the fee-for-service system cannot offer perfect incentives for laboratory tests. It may be more advantageous to consider alternative ways of affecting quantity that do not penalize the physician for ordering necessary tests, but do not reward him for over-ordering, such as bundling payment for tests with other services or employing utilization

controls. An approach that is exactly the opposite of bundling tests with other services could also limit unnecessary testing. If the decision-maker (usually the physician) has no personal financial incentive to order more tests because profits are made by another producer (e.g., an independent laboratory), then the physician should be less likely to order unnecessary tests, particularly if increased expenditures for tests limit the patient's willingness to pay the physician's fee. This is essentially the arrangement that now exists for the physician who sends tests out to an independent or hospital laboratory. Unfortunately, this method does not offer substantial incentives to the physician to see that the costs of the tests he does order are minimized, especially when his patients are well insured for laboratory testing.

There is a parallel between this system of ordering laboratory tests and physicians' prescription of drugs. A doctor who writes a prescription for a drug will make no profit on the prescription, unless the patient fills the prescription at a pharmacy in which the physician has a financial interest. Short

of kick-backs from the pharmacy (or the laboratory), the physician has no incentive to recommend unnecessary services. Interestingly, this situation does not exist in Japan, where physicians may dispense prescription drugs as well as diagnostic tests. In Japan, the financial incentive for doctors to prescribe unnecessary or unnecessarily expensive drugs is widely recognized.

Therefore, one might expect that physicians who send tests out to a laboratory would order tests differently than those who perform the tests in their offices, where a profit can be made. There is, however, one important imperfection in the incentives associated with separation of clinical decisions and ownership. The physician who orders tests has no incentive to assure that the tests are being performed at the least costly price that maintains quality, except in the role of the patient's or society's advocate. So there is a trade-off. If physicians cannot profit from ordering tests, they are more likely to order the correct volume but are less likely to have that volume produced at minimum cost. For this reason, the limitation of physicians to the $3

specimen collection charge may well increase the total cost of laboratory testing, especially if the effect on total volume is small. When physicians could buy tests from outside laboratories for their Medicare patients, they had an incentive to seek out the lowest price for such services. With the $3 flat fee, they no longer have an incentive to do so. They do, however, have an incentive to move the site of testing from an outside laboratory into the office, even if the costs in the office are higher, as long as the fee they can receive exceeds their costs.

To be sure, limiting physician charges to a $3 fee will probably reduce Medicare outlays as long as some physicians continue to use outside laboratories, assuming that the payment they formerly received exceeded the present independent laboratory price (limited by the new fee schedule) or assuming that their volume of testing decreases. The alternative of paying the same for a particular laboratory test in a particular market area, regardless of where or when it was performed, could well have achieved similar savings in Medicare reimbursement while continuing to offer incentives to choose the lowest cost source of supply, given quality and convenience.

7. Physician Payment Options and Incentives

In this section, we consider the impact of potential changes in physician payment systems on physicians' use of laboratory tests, site of laboratory testing, and on the quality of care and patients' access to it. As described earlier in this report, physicians can respond to financial incentives in six ways. They can:

1. Alter actual volume or intensity of tests per patient.
2. Substitute one service for another.
3. Perform tests at one site instead of another (e.g., in a hospital instead of in an outpatient setting).
4. Change the label for their services for billing purposes (e.g., "procinflation" or "procedure creep").
5. Modify their fees for services.
6. Promote or discourage patient access.

The "bottom line" measures of impact, which include each of the six separate effects listed above, are cost, quality, and access to care.

We will evaluate each of the proposed physician payment schemes in light of the criteria listed above, drawing on available evidence where possible. We caution that while data regarding physician practice patterns are available for fee-for-service systems and for capitation, much less evidence exists regarding packaging schemes. In these areas, it is necessary to extrapolate from related evidence to speculate about how physicians may respond.

We will consider seven alternative payment options, five of which are packaging schemes. The other two are fee-for-service systems (Table 5). One fee-for-service plan would use traditional CPR methods to determine levels of physician payment. The other would use a fee schedule to pay physicians.

The five packages include:

1. Inpatient physician services only (Physician DRGs)

TABLE 5. Potential Impact of Payment Schemes on Laboratory Testing

	How Would Outpatient Tests Be Paid ?	Change in Volume of Tests	Substitution of Tests	Site of Outpatient Testing	Labelling of Tests	Change in Actual Charge	Change in Quality and Access to Lab Testing
CPR	Probably a fee schedule	Depends on relative return on tests compared with other services	May cause substitution of tests for which profits are higher	Depends on profit, quality and convenience	Depends on fee structure, but unbundling and procedure inflation are likely	Depends on relative return on tests compared with other services	
Fee Schedule	Fee schedule						
Physician DRGs	By different mechanism	↑ outpatient testing, ↓ inpatient services per admission	Outpatient for inpatient lab tests	Depends on profit, probably ↑ office testing	No effect likely	N/A	↑ access to outpatient lab testing
Episode Management Package	From packaged payment	Probably no change but may ↓ testing	Physician time for technical services, outpatient for inpatient tests	Probably ↑ relative share to inexpensive independent labs unless office lab is less expensive (holding quality and convenience constant)		N/A	↓ access for expensive tests, perhaps ↑ access to screening tests (to detect disease)
Outpatient Episode Management Package		↓ outpatient testing	Physician time for technical services, inpatient for outpatient tests			N/A	
Outpatient Capitation	From capitation					N/A	
Full Capitation		Probably no change but may ↓ testing	Physician time for technical services, outpatient for inpatient tests			N/A	

2. Inpatient and outpatient physician services and outpatient ancillary services for an episode of illness (Episode Management Package).
3. Outpatient physician and outpatient ancillary services for an episode of illness (Outpatient Episode Management Package).
4. Capitation for outpatient physician services plus outpatient ancillary services (Outpatient Capitation).
5. Capitation for inpatient and outpatient physician services outpatient ancillary services, and hospital services (Full Capitation).

It should be noted that the appropriate tradeoffs among these options are not obvious. Options that score high on incentives for cost containment may be less suitable for guaranteeing access, but how are these two praiseworthy objectives to be balanced? Our rule of thumb here will be that if quality and access appear to be at satisfactory or acceptable levels, in some sense, then the decision

rule should be based on a comparison of costs. But because of the vagueness of the terms "acceptable" and "satisfactory" (or for that matter, "quality" and "access"), the reader will to some extent have to draw his own conclusions.

Fee for Service - Theoretical Considerations:. In considering the option of retaining the fee-for-service system but changing the level of fees for laboratory tests and physicians' services, it would be helpful to be able to predict the quantity of services that would be rendered in response to a change in fees. The problem is that the theory is fundamentally ambiguous and the empirical evidence is inconclusive: the most that one can say is that reducing what an insurer pays by, say, ten percent is unlikely to cut total expenditures by ten percent. But whether the resulting change in expenditures will be a decrease of seven percent or twelve percent is hard to say; there is even an outside chance that there could be an increase.

The reason that it is difficult to give a definitive answer to the question, "How will doctors respond to the changes in fee-for-service payment?" is

partly theoretical. There are a number of different theories of physician behavior in response to financial incentives, no one of which is universally accepted. What is even worse is that each of the theories is consistent with any direction of change in volume after a price change. As such, no theory is testable with price response data; the only sure prediction from theory alone is that anything is possible.

Suppose, for example, one postulates the conventional economic model of physician behavior--maximization of a utility function in income and leisure with no direct seller (i.e. physician) control over demand. Suppose also that a large third party payor is setting price levels but that the patient is subject to some copayment. Finally, suppose that the payor chooses to reduce what it pays for physician-produced laboratory tests but not to change payment for physicians' cognitive services. What will happen to the volume of laboratory tests and therefore total expenditures?

The answer depends on the level of price of the laboratory tests relative to marginal cost and on the

form of price setting. If all providers accept assignment, then reducing the price the provider receives for the test also reduces the price the patient must pay. Two influences will be felt by the physician. On the one hand, a fall in price will reduce the profitability of testing. If the prices fall enough so that testing becomes unprofitable, then quantity supplied will fall. But on the other hand, with a lower copayment, patients may be willing to accept a larger volume of tests--a fall in price of any good is usually thought to lead to a larger quantity demanded. As long as price is not depressed too far, the quantity of services will increase. Of course, there must be some price sufficiently low that supply will dry up.

In contrast, suppose one assumes that physicians can and will influence patients' demand to further physician objectives, one of which is income. This is, we believe, the essential notion behind the so-called "target income" or "inducement" models. A fall in the price paid for laboratory tests then has two additional incentives. It reduces physicians' net income and so presumably increases physician's

willingness to manipulate patient demand (or at least take advantage of potential, but as yet unmet, patient demand) to recoup some of their income. On the other hand, it makes demand manipulation for laboratory tests less profitable, which should presumably reduce the incentive to manipulate.

The patient's response to a change in price also should be considered. If patients pay nothing out of pocket or ignore what they do pay, they may not only be willing but be eager to accept more tests after a fall in fee levels for the tests. If the only way to make treatment of the patient more profitable for the physician is for the patient to permit additional profitable tests, then one can view those tests as part of a quiet conspiracy on the part of physician and patient to maintain the physician's income from Medicare, despite an attempt by Medicare to reduce it. Even if the patient finds the tests inconvenient--and so would have resisted them at the higher price level--acceptance of an inconvenient test may be preferable to finding a new physician or losing

the advantage of acceptance of assignment by one's current physician.

Howevermuch physicians may want to shift demand, they are constrained by what patients are willing to accept and by physicians' own presumed dislike for participating in such behavior. Even if the laboratory test fees fall and even if physicians decide to try to recoup some of their loss in income, they may find it preferable to do so by increasing the volume of other services, especially in view of the reduced profitability of laboratory tests.

The empirical literature reviewed earlier in this report finds some natural experiments in which volume rose following a cut in fee levels, but this literature offers little guidance on the effect of a change in testing alone, given the small share of laboratory fees in total payments. It is obviously not possible to tell whether the increased volume reflects demand creation, an increase in quantity demanded for something that has become cheaper, or a quiet conspiracy to extract more Medicare resources for the patient-physician combination. Furthermore, these natural experiments generally included a

change in payment for cognitive services as well as for ancillary services. It does not, in any case, appear that cutting fee levels produces proportionate reductions in total expenditures. There is some volume offset, although the increase does not appear large enough to return expenditure to its former level. Instead, expenditures fall somewhat, just not in proportion.

Of course, if expenditures do not return to their former level, neither does physician income. This is another piece of evidence--if one is needed--against a crude form of the target income theory that postulates there to be a fixed target that physicians will want to achieve no matter what. It is, however, consistent with some demand creation. In the case of the impact of changes in the price of laboratory tests alone on volume, any impact on the volume of testing is consistent with any theory. So neither the neoclassical (which suggests that increases in volume are a response to already existing demand as price falls) model nor the induced demand model yields crisp predictions about the way in which

quality would be expected to respond to a change in payment levels for laboratory services.

While the effect of a change in fees for laboratory tests on the volume of tests may be ambiguous, the impact of a change in fees paid for physicians' services on their prescription of laboratory services may be more predictable. With increased fees for cognitive services but no change in the fees for laboratory tests, it is unlikely that physicians would maintain their previous levels of prescribing tests. If the doctors were performing tests even in small part because of financial incentives to do so, the number of tests ordered may fall with an increase in the fee for cognitive services. If fees for cognitive services are increased, a rational physician might substitute cognitive services while maintaining patient satisfaction and quality of care.

If this substitution were calculated to maintain the physicians' net income, then its effect on total expenditures would depend upon the profit from testing versus the profit from offering cognitive services. The profit from offering cognitive services will

depend on the price for cognitive services versus the physicians' cost - both financial and psychic - of spending more time with the patient. If the physician sends laboratory tests out to an independent laboratory and only collects the $3 fee, then the profit from testing is likely to be small, the physician is probably not motivated to perform tests for income, and there is likely to be little impact on test volume when fees for cognitive services change. However, for tests performed by the physician (e.g., in-office laboratory tests), the profit is sometimes considerable, financial incentives are likely to play an important role in prescription of services, and the impact on volume may be substantial.

This scenario would predict that with an increase in physician fees, but not in fees for laboratory tests, a decrease in office laboratory tests would be experienced, with little change in tests sent out. The converse would be the case with a fee freeze only on physician services (or a decrease in physicians' collections for cognitive services), depending on the profitability of testing. The volume of profitable testing would increase.

Therefore, in addition to affecting the volume of services, changes in physician payment will influence the site of testing. A decrease or freeze in physician payment for cognitive services is likely to encourage physicians to perform tests in a site where profits can be increased. As a result, some barriers to in-office testing (e.g., the "hassle" of supervising a laboratory) may become less of an obstacle. The physician also may be more likely to make up for lost income on cognitive services by changing the label of services provided (e.g. unbundling) or by refusing to accept assignment (which would simultaneously increase the fee for services rendered and limit patient access).

One health care management consultant has already observed these changes taking place (D. R. Seubert, personal communication). Many of his clients find themselves limited by the $3 drawing fee for tests sent to an independent or hospital laboratory and by reduced fees for physician services. These physicians are investigating the advances in laboratory equipment that have reduced the cost of in-office testing and will allow them to do in-office

testing at a fee that would be competitive with the independent and hospital laboratories. These physicians are "looking for ways to maintain their level of income through the use of ancillary services that were previously directed to laboratories".

Therefore, consideration of the influence of fee-for-service physician payments on laboratory testing should separate the effect of the payment for cognitive services and the payment for laboratory tests. At one end of the spectrum, a low fee for cognitive services and a high fee for tests would encourage a high volume of testing performed by in-office laboratories for those tests for which the fee is substantially greater than the marginal cost of production. Conversely, a high fee for cognitive services and a low fee for tests probably would induce fewer tests, but the site of testing is less predictable, depending upon marginal income, patient convenience, cost and other factors. A low fee for laboratory tests could compromise the quality of in-office testing and patients' access to it if the level of payment is too low (although one might argue that lower profits for doctors would induce them to

send tests out to laboratories where quality is reportedly higher, at least prior to the current generation of in-office equipment). Other combinations of changes in fees than these two extremes would have even less easily predicted effects on the volume, quality and cost of laboratory testing, and patients' access to it.

Fee-for-Service Options. Although Medicare is considering two fee-for-service options (CPR and fee schedule), we will describe a fee-for-service system as one option. There are three reasons for this approach. First, the Medicare CPR system has evolved into a de facto fee schedule system with the majority of billings (over 80 percent) at or above the payment limit (Etheredge L, 1984; Committee on Finance, 1984; Hammons, Brook, Newhouse 1985). Second, the Medicare physician payment system is really a generic fee schedule, with CPR serving as a means of setting payment levels. Third, and most important for this analysis, the potential impact on laboratory testing appears to be the same regardless of whether the physician fee schedule is determined by CPR or some other means (Table 5). Any differences would depend

on what an individual physician's fee, as set by a fee schedule, would be compared with his fee set by the CPR system. If a metropolitan specialist receives a higher fee for the same service than a rural general practitioner, his incentives may be different. More important, though, are the relative fees within the schedule (which would influence the physician's mix of services) and the absolute level of the fees (which would principally influence the volume of services).

The amount of payment to physicians may be determined by CPR, or by a fee schedule determined by competitive bidding, administrative decree, or negotiation. Table 5 summarizes the likely impact of changes in these fees. The impact of the CPR system or of a fee schedule for physician services on use of laboratory tests most likely will be determined by the relative financial return on each type of service. As described above, the return on laboratory testing potentially can be substantial, especially for high volume laboratories.

An important goal of an equitable, technology-neutral physician payment system should be to pay for services according to their relative costs in some sense (recognizing that payments based on average cost

will still offer a profit for the additional tests which is performed at marginal cost and that incentives depend on the relationship between price and marginal cost). At a minimum, one does not want to pay more than average cost for any service. The payment system should provide neither disincentives nor strong incentives to provide particular services, the assumption being that patient need and physician judgment should guide clinical decision-making. Exactly how marginal and average cost information might feasibly be used to generate such a system is far from clear. If a policy decision were made to encourage certain types of practice (e.g. screening and other forms of prevention), modification of the relative fees could be used to try to influence practice style. When these modifications in levels of payment diverge from the resource-based prices, they send clear messages to physicians about patients' (or payers') values for these services. In these instances of divergence, the relative value scale really reflects values (i.e. utilities or preferences) as well as input costs.

A fee schedule that pays for physician laboratory services according to the relative marginal

cost of providing the service could well result in a decrease in laboratory use and an increase in cognitive services. The reduction in laboratory test use would occur relative to the degree to which physicians were enjoying financial return on laboratory testing prior to the new fee schedule, compared with to their financial return on cognitive services, and considering the difference between the fee and marginal cost. For instance, if physicians were sending all tests out to independent laboratories and not relying on revenues from testing, then a change in the fee schedule for laboratory testing would have little effect on physician use of testing.

A change in fees for laboratory and cognitive services would have the most impact on physicians who maintain in-office laboratories and who rely on those laboratories for revenue. The more dependent physicians are on financial return from in-office laboratory testing, the more willing they may be to adjust volume of testing or cognitive services based on relative payment. However, for most physicians laboratory testing probably accounts for a small proportion of total physician revenues. If the laboratory fee schedule declines enough, then in-office laboratory testing will become unprofitable

and may be maintained only for reasons of patient convenience. As stated earlier, the amount of patient copayment that would be necessary could also influence these decisions, as would the proportion of the physician's practice involved in that payment system.

Independent and hospital laboratories would also face a new financial reality with reduced fees for laboratory services, the importance of which would be determined by how much of their volume was from Medicare patients. A lower fee schedule could spell closure or at least reduction in services from some independent laboratories. This could, in turn, influence the way in which physicians use laboratory tests. This could decrease the availability of independent laboratories, and might induce some physicians to use more in-office testing.

A change in the fees paid for laboratory tests in a CPR or fee schedule system could also alter the labelling of tests. Both unbundling and procedure inflation would probably occur with decreases in prices as physicians attempt to recover some of their threatened income.

If fees were decreased only for laboratory tests, some patients may have their access to tests

limited, although it is likely that the reduced testing would occur principally for tests of questionable or uncertain clinical utility. If physicians do substitute cognitive services for the more poorly paid tests, patients could experience an increase in access to physician time as access to tests decreases.

In essence, the effect of a change in fees paid for laboratory tests, whether in a CPR system or a fee schedule, will depend more upon the relative financial return to physicians for laboratory and cognitive services, compared with the marginal cost of providing these services. Therefore, the system is less important than its relative prices. This is likely to be so whether fees are set by a relative value scale based on marginal or average production costs, or set by negotiation or competitive bidding. Because of the likely phenomenon of declining marginal cost but constant price with volume, a fee-for-serivce system cannot be neutral to the use of increased numbers of tests so long as the doctor can make a profit on the tests. Any fee-for-system system that encourages additional testing will probably require carefully

designed ancillary services utilization review (Eisenberg, 1982).

Packaging Services. With packaged payment, a single predetermined amount is paid to a physician or institution for the services in that package. If the cost of producing the services provided exceeds the package payment, then the physician or institution is at risk and takes a financial loss on the patient. If, however, the total services provided cost less than the payment, the physician or institution profits on the patient. The package amount can be based on an episode of illness (e.g., a hospitalization) or on a time period (e.g., a year of care).

Packaging services provides an incentive for physicians (if they are placed at risk) to consider the marginal value of each test to patient care and the marginal cost of providing the test. For laboratory testing, packaging may induce physicians both 1) to provide only as much testing within the package as is necessary to offer what the physician (or regulators) regard as quality care and satisfy the patient and 2) to purchase or produce laboratory tests as inexpensively as possible, given the same kind of "adequate" quality of testing. However, the

scope of the package may influence the laboratory tests that are provided at different sites, since incentives may exist to shift services to different sites. Table 5 summarizes the likely effects of five different systems of packaging payment for medical care on the use of laboratory tests.

Packaging Option 1: Inpatient Physician Services Package. This option could also be termed "Physician DRGs" because the payment amount would be based on a case-mix adjustment, such as DRGs in the proposals now receiving the most attention. Many of the generic issues raised by this form of packaged payment have already been addressed in this report. The following comments focus on the effects on laboratory test use.

If inpatient physician services are paid in a package per episode of hospital care, the incentive will be to perform as much profitable laboratory testing as possible outside of the hospital, particularly in the physician's office laboratory (Lion, Henderson, Malbon et al, 1984). Profits for the physician would depend on the arrangement and fees for outpatient laboratory testing and the cost of

production. Other factors, such as cost to the patient and patient convenience, would also play a role. This revenue from in-office testing would help to offset losses that may occur on the inpatient side as the physician's payment there becomes constrained. While these incentives may induce physicians to perform profitable tests in the outpatient setting, another influence may cause them to substitute inpatient for outpatient tests. This would occur if physicians felt that a diagnostic evaluation would justify an admission and if their net revenue from the inpatient packaged payment were greater than that from outpatient testing. However, since few laboratory tests would justify admission (while diagnostic procedures might), this substitution is not likely to occur frequently.

While physicians do bill for certain procedures performed in the hospital, the decision-making physicians (the attending and consulting physicians) rarely have personal financial motivation to order laboratory tests in the hospital. The pathologist's form of payment may influence the incentives for the laboratory's director, but there is no evidence that

this influences the utilization patterns of attending and consulting physicians.

Limits on payment of inpatient physician services also would encourage greater provision of other outpatient physician services in addition to laboratory testing. Physicians may encourage more frequent office visits to monitor patients and prevent or shorten hospitalization. This in itself may increase outpatient laboratory testing, since the amount of laboratory testing is correlated with the number of office visits (Danzon, Manning, Marquis, 1984). This possible shift of testing to outpatient settings with limits on inpatient physician payment could exacerbate the shift that is apparently already underway for expensive technology such as magnetic resonance imaging and computerized tomographic screening as a response to constraints on hospital payment because of DRG-based prospective payment.

Quality of care may be affected adversely if physicians delay necessary hospitalizations because of the restrictions on inpatient physician service payment or if they discharge patients early. Access to care also may be reduced for patients likely to

require hospitalization, such as the chronically ill or very old. On the other hand, a risk of paying physicians for inpatient packages is that they might admit patients briefly to have tests that could have been performed in the outpatient setting. Clearly, monitoring for both possibilities is necessary.

Packaging Option 2: Episode Management Package (Inpatient/outpatient episode-of-illness physician service package plus outpatient ancillaries). In this arrangement, for an episode of hospital care, physician fees for pre-and post- hospitalization visits and for hospital visits would be paid in a lump sum along with outpatient ancillary services. Included in that amount could be consultant physician visits as well. Surgeons and obstericians have long charged a package fee for a specific procedure or for maternity care. Generally, however, these package fees have not included consultant physician services.

This packaging option could have a detrimental impact on quality of care if physicians seek to limit the amount of physician and ancillary services provided in order to maximize profits or reduce losses. This possibility is less likely, however, if

only because of the threat of malpractice litigation. We know of no evidence of such limits imposed by surgeons or obstetricians. Costs of their inpatient cases, however, tend to be more predictable than those of internists, family physicians, or general practitioners. In addition, such specialists now may charge "extra" for complicated cases, as for a caesearean birth vs. normal vaginal delivery.

On the other hand, payment by episode of illness could increase patients' access to testing. Physicians will be aware of the likely higher payment levels for patients with secondary diagnoses and may increase their use of screening tests to detect disease. They may also increase testing to document the existence of an episode of illness that justifies admission.

Another risk of this packaging option is to patient access. Patients who are or are likely to be chronically ill, seriously ill or have multiple, simultaneous problems (such as the very old), may find it more difficult to locate physicians who will care for them. This is especially likely if the episode of care is defined in a way that includes chronic care or

does not recognize multiple secondary diseases and outliers. Physicians may be less likely to accept Medicare patients unless measures are instituted that would protect physicians against serious financial loss (e.g. stop-loss insurance).

Packaging Option 3: Outpatient Episode Management Package (Outpatient physician/ancillary services episode-of-illness package). Whereas packaging options 1 and 2 were built around an episode of inpatient care, this option includes only outpatient physician services and outpatient ancillary services. These services, unrelated to a hospital stay, reflect the majority of ambulatory care. The unit of payment would be an outpatient episode of illness. An episode of illness, however, can be difficult to define, particularly if it is an acute exacerbation of a chronic condition. This definitional problem is especially important for Medicare patients because they are particularly likely to suffer from chronic diseases (Lion, Henderson, Malbon, 1979). Moreover, Medicare patients are more likely to present more than one problem at a visit.

Nonetheless, if an episode of illness could be defined, then a combination of cognitive and ancillary

services payments into a package would induce the physician to balance the mix of services in a way that provides quality care and satisfies the patient, as well as increases the physician's profit. The volume and mix of services, the amount of substitution that would occur and the choice of a location for testing would depend upon the relative marginal costs and marginal benefits of each. Physicians would be likely to seek the least expensive method of providing laboratory tests, but may be motivated to reduce the number of tests from the number with some positive expected contribution to health to the number that have an expected benefit that the doctor deems to be equal to or greater than their cost. In this case, physicians will balance their patients' potential gain with their own cost of producing the tests and their own gain in the long run by satisfying their patients. The risk of poorer quality care or access to care is substantial with these incentives for physicians to reduce the cost of providing outpatient care. Physicians may be more likely to substitute inpatient care for outpatient care because of the limits on outpatient payment. This may be especially

true for chronically ill patients or for patients likely to do less well with outpatient care.

As in the case of the second packaging option (the Episode Management Package), physicians may be tempted to increase their use of tests (either screening tests to detect diseases that would signal an episode of illness or diagnostic tests to document the primary or secondary diagnoses).

Option 4 and 5: Capitation. Option 4 (Outpatient Capitation) entails capitation for outpatient physician and ancillary services only, whereas Option 5 (Full Capitation) includes hospitalization as well. We consider these two options together, using the contrast between them to make several fundamental points about the impact on laboratory testing.

Capitation payment most commonly is made to an institution, such as a health maintenance organization, which bears the financial risk for care. Physicians may be salary and may receive a bonus (or penalty) if expenditures are kept below (or exceed) a target amount or they may be paid through fee-for-service. The physician's or organization's

incentive would be to purchase or provide laboratory testing at the lowest possible price while maintaining adequate quality of testing and patient satisfaction. This would suggest that hospital and independent laboratories would probably be preferred over physician in-office laboratories, except for tests that can be performed less expensively in the office or for which immediate turn-around is important.

It has been postulated that patients in capitation plans undergo more outpatient care, including laboratory testing, and are hospitalized less often than patients in fee-for-service systems. Two lines of causality are implied:

1. By promoting more preventive care on an ambulatory basis, hospitalizations are avoided, (e.g. diabetes controlled on an outpatient basis prevents hospitalization) or
2. Aggressive ambulatory care substitutes for inpatient care (e.g., minor surgical procedures) are performed in outpatient setting.

The evidence on use of laboratory testing in pre-paid and fee-for-service settings is mixed. Earlier

studies found contrary results, some showing greater use of outpatient laboratory tests for patients in pre-paid systems and others showing the opposite (Perkoff, Kahn, Haas, 1976; Perkoff, Kahn, Mackie, 1974; Scitovsky, 1981; Hastings, Mott, Barclay et al, 1973; Eisenberg, 1985, The internist.). More recent studies, using better experimental controls, have consistently found no significant difference in use of laboratory tests for outpatients (Danzon, Manning, Marquis, 1984; Manning, 1983; Epstein, Begg, McNeil, 1985, The use; Yelin, Henke, Kramer et al, 1985). Two of the studies, however, were confined to discrete patient populations--those with chronic hypertension (Epstein, Begg, McNeil, 1985, The use) and those with rheumatoid arthritis (Yelin EH, Henke CJ, Kramer JS et al, 1985)--thereby strengthening the comparative results but weakening the generalizability.

Whereas Outpatient Capitation is likely to reduce outpatient testing with a possible increase in inpatient testing, Full Capitation may induce a substitution of outpatient testing for inpatient tests. In either case, the total number of tests may not change, but a decrease in testing is more likely

with Full Capitation. Also in either case, physicians may substitute their own time for laboratory tests depending on the relative cost of each. If the cost of laboratory tests to the individual physician is not apparent (e.g. in large HMOs with pooled risk and few direct physician incentives), then the physician will be less likely to substitute his own services for tests, even if it is more efficient for the HMO to do so.

There is little evidence that access or quality of care is diminished under capitation, despite the financial incentive to reduce utilization of services. However, the lack of evidence may reflect stronger internal and external regulations of access and quality of care, especially after the California Medicaid HMO scandals of the early 1970s. Perhaps the forces that affect physician ordering, such as concerns for patient well-being or concerns for one's own reputation, also tend to outweigh financial incentives in pre-paid settings. This may be especially true regarding laboratory testing since the link between a bonus or penalty and each individual order for a relatively inexpensive laboratory test would be difficult to make.

Capitation includes the same risk as other packaged payment plans to avoid responsibility for patients who are chronically ill or have multiple medical problems. Therefore, access could be limited unless assurance was made that "cream-skimming" would not occur. On the other hand, access to preventive services (e.g. screening tests) could be increased if the physicians believe that the tests will detect disease at an earlier stage, when it may be less expensive to treat.

General Comments on Packaged Payment. The effect of packaged physician payment on laboratory testing depends upon two key variables: whether the cost of outpatient testing is included in the package and whether the cost of hospitalization is included. When neither is included, the physician will be encouraged to perform outpatient testing if the price received exceeds the marginal costs of such tests. Patients' access to laboratory tests could be enhanced, but unnecessary services may be provided. Physicians will be induced to perform tests in the most profitable - but not necessarily the lowest cost - site, which would be in-office testing for most

tests if payment for testing does not change. This shift to in-office testing is more likely to occur in large group practices, where the fixed equipment cost can be spread over a larger volume of tests. Another trend should be the establishment of physician-owned independent laboratories in states that permit them.

However, at the other extreme, when the cost of outpatient testing is included in the physician payment but the cost of hospitalization is not, the physician will be induced to reduce outpatient testing and to carry out those outpatient tests that are ordered in the least costly manner. Inpatient testing would probably increase, but DRG-based limitations on hospital payment would be a constraint on this increase (or at least produce potential hospital-physician conflict). Thus, Option 3 (the Outpatient Episode Management Package, with tests included) and Option 4 (Outpatient Capitation) would probably result in lower costs for outpatient laboratory testing.

Option 5 (Full Capitation) would probably result in fewer hospital admissions. Since outpatient testing might be carried out to avoid hospitalization, testing could increase. However, this incentive would

be at least partially offset by the inducement to avoid outpatient costs as well.

Because the quality of care and access to care may be limited by arrangements that place the physician at risk for high costs of care (as do all these packaged arrangement, to differing degrees), these outcomes should be monitored if packaged payment of physicians is introduced. The quality of laboratory testing will depend upon the type of test, the site of service and the pressures on that site to cut the cost of production. Some might argue that physicians' profit from laboratory testing should be eliminated so that tests will be sent to hospital or independent laboratories. Others would suggest that a reasonable profit for physicians could enable them to perform in-office tests on new, high quality equipment and hire trained technicians to carry out the tests at a site where results can be made readily available to the patient.

Conclusions

We have covered a wide range of material in this paper. We have described why physicians order laboratory tests, analyzed payment systems for physician services and laboratory tests, evaluated financial incentives for physicians to use laboratory testing services, described different laboratory testing sites, and predicted the impact of different physician payment systems on laboratory use. In this conclusion we highlight several points.

1. The bulk of this paper discusses financial incentives and physicians' potential responses to those incentives. That was our mandate. We want to place this analysis in its appropriate context, however. As described in the chapter on why physician order tests, financial incentives are neither the sole nor even the greatest factor influencing physicians' decisions to order laboratory tests. Patients' needs come first, at least for most physicians.

2. The evidence on whether or not physicians induce demand for medical services is poor, especially for laboratory tests. Although many may agree that

physicians could induce demand for laboratory tests if they wanted to, it requires an intellectual leap to conclude that, in fact, they do. The policy question is, given that physicians could induce demand, can we avoid giving them the financial reason to do so adn at the same time still offer incentives to render care when it is needed?

3. If financial incentives do affect the volume of tests ordered, then the effect most likely would be at the margin. This is the "grey area" of testing where the clinical necessity for at est is uncertain. Financial incentives may nudge the decision one way or the other. Since this grey area in clinical decision-making is generally agreed to be constitute a large portion of medical practice and since many believe that physicians are amenable to financial persuasion, we would expect to see significant differences in ordering between the fee-for-service setting and the full capitation setting. Financial incentives under fee-for-service would "nudge" they physician to order the additional test whereas the financial incentives of an HMO would discourage that additional test. However, it has been demonstrated several times for comparable sets of patients that

volume of testing in the fee-for-service and HMO settings are essentially the same. As such, for laboratory testing in particular, concerns about induced demand may be much ado about very little, or at least they are less important than other factors that cause variation in medical practice.

4. Physician time and laboratory testing are both complementary and substitutive services. Certainly laboratory test results can provide additional clinical information that the physician could not obtain otherwise. Laboratory tests also are used to verify information that the physician has gleaned through a physical examination or history-taking. When physician servcies and laboratory tests are paid at conspicuously different rates, given the resource requirements, then physicians may be encouraged to order laboratory tests for the financial return.

5. Under packaging (including capitation) schemes in which both physician servcies and laboratory tests are paid within the same package, the substitution between physician servcies and laboratory tests relates more to the cost of providing the service (given fixed reimbursement) and benefit to the

patient. Which type or mix of services is going to get the job done least expensively?

6. Under packaging or capitation schemes in which laboratory testing is paid through fee-for-service, barring drastic reductions in payment rates, laboratory tests are likely to be highly profitable for someone. When the physician is permitted to reap the profit, as in office-based testing, the incentive will be to order additional tests. When the physician is forbidden direct payment for laboratory tests, as for tests sent out to independent laboratories, there is little incentive for the physician to seek the least costly facility for testing services. This lack of concern for cost will apply to <u>all tests</u> sent out to independent laboratories, not just those in the "grey area" of testing. Because of the volume of tests involved, this lack of concern for costs may be responsible for much greater overall costs of testing.

8. The greatest change occurring in laboratory medicine now is the movement of tests previously done only in independent or hospital laboratories out to physicians' offices. Physicians have long done some laboratory testing in-office, but now available are

automated blood chemistry analyzers and other testing equipment, some of it connected to small computers that perform calculations and display results. Few issues in laboratory medicine are as highly controversial as this move to in-office testing. The concern is chiefly about quality: What level of quality is necessary? Do the new technologies really provide adequate quality control? Are trained laboratory personnel necessary to achieve quality testing in the office setting? How much does quality control cost?

9. To the extent that outpatient testing is paid at high enough prices through a fee-for-service system and physicians are permitted to charge directly for in-office laboratory testing, in-office testing will increase. When outpatient testing is paid via packages or capitation arrangements, in-office testing will continue only insofar as it serves to attract patients because of the convenience factor or because it provides higher quality care. If the decision were based on the cost of testing alone, in-office testing, with its relatively high costs per test, would probably not prevail in a packaged environment (including capitation). The patient convenience

factor, in these days of excess supply of physicians, should not be underestimated, however.

10. Because of the potential incentives for underutilization and overutilization with various payment schemes, each should be accompanied by a system of monitoring appropriateness of utilization, access and quality. While a quality assessment system may be sufficient to determine whether substantial problems exist, a quality assurance mechanism will be necessary to identify individual providers who violate standards and to correct their inappropriate practices.

11. Most of these predictions about physicians' responses to different payment schemes assume that doctors weigh their patients' benefit with their own as they decide when, where and whether to order and perform laboratory tests. If general concern about medical care costs continues to increase, then physicians will be exposed more forcefully to a third influence, consideration of the social good. Weighing the patient's good, the physician's self-interest, and the general social good together will be a difficult task for physicians. It will raise important eithical

questions, including those of equity and whether the physician should try to serve as the patient's agent and the agent of a society with limited resources simultaneously.

12. Overall, the choice of a physician payment scheme:

a. may not affect the total volume of laboratory testing substantially except to the extent that it also alters the relative payment for tests and other services.

b. will probably affect the site of testing. If the incentive is to control costs, then the larger independent or hospital laboratories should be used. If the incentive is to provide one-stop shopping for patients, then in-office laboratories may be preferred. If the payment scheme permits physician profit on individual tests, then utilizaiton will follow, particularly in physician-office testing.

c. may affect quality of testing if in-office laboratories do provide an inferior quality

testing and if the payment scheme promotes in-office testing over other sites.

d. may affect patient access to care. Fee-for-services systems that pay adequately tend to promote access. Those that limit payment and place the physician or institution at risk tend to increase access for the generally healthy and discourage access for the chronically ill with multiple disorders. Access to testing will follow general patient access.

e. will affect the direction of technology development. To the extend that in-office testing is encouraged through financial incentives to physicians, this area of technology will continue to develop. Concerns about quality will be addressed, at least in part, through technological improvements. If in-office testing is discouraged through financial incentives, this technology may still flourish depending on the importance of patient convenience in attracting and keeping patients.

In conclusion, there is no simple answer to the effect of physician payment on the use of laboratory tests. There is no obviously superior arrangement for physician payment to optimize their use of laboratory tests. Options that seem to offer promise to reduce overall costs, such as capitation, may have no effect on laboratory testing. Other arrangements have the potential for unpredictable substitution of services. A major problem with fee-for-service payment seems not to be the system itself, but the relative levels of payment for cognitive and procedural services. On balance, any of these options could serve to encourage physicians to offer cost-effective, accessible medical care if 1) careful consideration is given to the potential effects on substitution of care, limitations on access to care and jeopardy to the quality of care, and if 2) the levels of payment are chosen to encourage efficient physician practice patterns.

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Appendix A

Individuals Consulted for Study

1. Judith Barr, Ph.D., Northwestern University
2. Leif C. Beck, Management Consulting for Professionals, Philadelphia
3. Peter Budetti, MD, JD, Staff, Congressman Henry Waxman, U.S. Congress
4. Donald Butler, Clinical Practices Administrator, University of Pennsylvania
5. Paul Campbell, Health Industry Manufacturers' Association
6. Thomas E. Colman, Ph.D., Smith-Kline Bio-Science Laboratories
7. Arnold Epstein, MD, Harvard School of Public Health
8. Robert B. Edmiston, MD, Blue Shield of Pennsylvania
9. Thomas Fay, Health Care Management Consultant
10. Harvey Fineberg, Ph.D., MD, Dean, Harvard School of Public Health
11. Harry Groome, President, Smith-Kline Bio-Science Laboratories
12. Dell G. Gray, Medical Group Practice Administrator
13. Leon Grotkowski, MBA, Laboratory Business Manager, Hospital of the University of Pennsylvania (HUP)
14. Edward A. Kaufman, MD, Smith-Kline Bio-Science Laboratories
15. Mary Alice Krill, Ph.D., Medical Group Management Association

16. John N. McConnell, National Committee for Clinical Laboratory Standards

17. S. Rowe Miller, Management consultant, Tucson

18. Jane E. Nugent, Smith-Kline Bio-Science Laboratories

19. Barbara Piasecki, National Committee for Clinical Laboratory Standards

20. Wayne Roe, Management Consultant, Lewin and Assoc., Washington

21. Gary Schneider, Health Industry Manufacturers' Association

22. D.R. Seubert, Management Consultant, Minneapolis

23. Steven A. Schroeder, MD, University of California, San Francisco

24. Donald Young, MD, Director, William Pepper Laboratory, HUP

25. Chester M. Zmijewski, Ph.D., Associate Director, William Pepper Lab, HUP